October 1978

bo Slip

ALAMEDA COUNTY SOLID WASTE MANAGEMENT AUTHORITY

BROWN AND CALDWELL
CONSULTING ENGINEERS

MEDIUM-AND LONG-TERM SOLID WASTE FACILITIES PLAN

80 00674

BROWN AND CALDWELL

CONSULTING ENGINEERS

October 25, 1978

Mr. Arthur L. Vargas
Alameda County Solid Waste
Management Authority
399 Elmhurst Street
Hayward, California 94544

145-8

Subject: Medium- and Long-Term Solid Waste Facilities Plan

Dear Mr. Vargas:

In accordance with our contract dated December 12, 1977, we are hereby submitting 200 copies of the subject report. Chapter 1 contains the background and summary of solid waste planning in Alameda County and a description of the short-term actions taken by the Authority which affect the Medium- and Long-Term Facilities Plan. Chapter 2 presents the Medium- and Long-Term Facilities Plan.

Appendix A contains an update of information presented in the Solid Waste Management Facilities Plan on hazardous wastes, litter, demolition debris, sludge, industrial wastes and an inventory of collection systems. Supporting data for the alternative facilities programs and management systems are presented in Appendices B through K. Appendix L contains the alternative programs which were presented in public hearings and which were considered by the Authority in their selection of a final facilities plan. Appendix M contains the EIR and responses to comments on the draft EIR. Appendix N is a summary of the background information used by the Authority when it took the short-term actions which affect the Medium- and Long-Term Solid Waste Facilities Plan.

We are also submitting, under separate cover, 400 copies of the executive summary of the plan. The executive summary contains Chapters 1 and 2 of this report.

A presentation of the plan will be made at your request before the State Solid Waste Management Board. That meeting will conclude our

activities as authorized under the December 12, 1977 contract. We are available to discuss our findings with you and the other members of the Authority at your convenience.

Very truly yours,

BROWN AND CALDWELL

Hilary Theisen

Hilary M. Theisen
Project Manager

Patrick Maroney

Patrick M. Maroney
Project Engineer

HMT:PMM:br
Enclosures

ALAMEDA COUNTY SOLID WASTE MANAGEMENT AUTHORITY

BROWN AND CALDWELL PROJECT STAFF

ENGINEERING

Fredrick L. Clark
Patrick M. Maroney, Project Engineer
Gordon J. Sewards
Hilary M. Theisen, Project Manager
Jonathan K. Tuck
Ira J. Wright

FINANCE

Marvin Winer

ENVIRONMENTAL IMPACT REPORT

Robert D. Smith

REPORT PREPARATION

Lloyd Burns
Margarget Purdy
Barbara Reedus
Walter Salas
JoAnn Steffler

CONTENTS

CONTENTS (continued)

LIST OF TABLES

LIST OF FIGURES

*Foldout figures follow page number noted.

CHAPTER 1

INTRODUCTION AND SCOPE OF WORK

The State of California requires that solid waste management plans be developed for every county in the state. Alameda County has a policy plan and a short-term facilities plan which have been approved by the State Solid Waste Management Board. As a condition of its past approvals, the state required Alameda County to develop a medium- and long-term facilities plan. The satisfaction of that requirement is the responsibility of the Alameda County Solid Waste Management Authority. Brown and Caldwell was retained by the Authority to assist in the development of the medium- and long-term facilities plan. This chapter presents the conditions under which the plan was developed. Separate sections cover the background and interrelationship with previous plans, the scope of work for this plan, and the structure of plan documentation and approval.

BACKGROUND

The medium- and long-term facilities plan is to be an integral part of the existing solid waste management plan. The existing plan has two elements, a policy plan and a short-term facilities plan. An outline of work is presented in the short-term plan that clearly establishes the intent of the agency to develop a medium- and long-term plan.

The elected officials of 17 agencies in the county executed a joint powers agreement which created the Alameda County Solid Waste Management Authority. That Authority, created in November 1976, was granted the powers of plan development in March 1977. The Authority then developed the short-term facilities plan. That plan contains the following statements of policy:

- Any jurisdiction which can use and import garbage can develop a sophisticated system for dealing with the program and may proceed as long as the system added is advanced or improved over burial and is in conformance with the goals of the plan.

- Conservation of landfill sites should be encouraged through use of compaction at existing sites; source separation and source reduction.

- The Solid Waste Management Authority shall develop and adopt administrative procedures to facilitate implementation of the Solid Waste Management Facilities Plan at the earliest possible time.

In addition to these policy statements from the short-term plan, there are other policy statements from the plan which bear on the current planning effort. All planning policies are important and can be found in the plan. In the interest of brevity, only the facilities policies are reproduced here.

Management/Operations (Facilities)

A. General Policies

1. Private industry is given an opportunity to perform some or all waste activities.

   a. It is the consensus of local opinion that local industry continue to play the major role in waste collection activities.

   b. Coordination will be established between the scavenger companies serving local jurisdictions so that short-, mid-, and long-term changes and solutions are evaluated and understood and conform to the County-City-Special District Solid Waste Management Plan.

   c. Changes which are made in the waste management system to achieve local, state, or federal goals of material or energy recovery may alter the costs of the refuse service; it is understood that costs and benefits of achieving said goals are to be passed to the users of the system.

   d. Needed facilities will be developed in conformance with Plan Policies and with the concurrence or approval of the County Solid Waste Management Agency.

2. Local jurisdictions are responsible for collection services and franchising for that service; rates and franchise fees are a local prerogative, and local jurisdictions may benefit by recognizing the goals of the Joint Refuse Rate Committee and the areawide evaluation of common problems.

   a. That cities and special districts will continue to accept the responsibility for the waste generated within their borders and retain the right to dispose of or utilize their solid waste to their best advantage.

3. Capital intensive programs for material and energy recovery may be publicly or privately funded at some future time based upon evaluation and decision of the Joint Powers Board.

4. The goal of this plan is at least 67 percent combined resource materials and energy recovery by the early 1980's and 92 percent by 1990's (alternatives 1980-C and 1990-C); the options of composting the organic fraction (such as the Bay Delta Demonstration) will continue to be explored.

   a. It should be realized that the adoption of these goals is dependent upon at least two conditions: (1) the favorable circumstances with technology fully developed and adequate demand for reclaimed and recycled waste products, and (2) goals in view of present technology. Decisions ultimately will be based upon evaluation of technical feasibility, cost and benefits derived.

5. Transfer and processing facilities, long haul and disposal sites existing or proposed are to be in conformance with the Plan.

6. The closing of close-in disposal sites will necessitate the location of satellite transfer stations at several points throughout the county.

   a. The location of the transfer stations should be carefully examined for efficiency and cost-effectiveness and a countywide transfer facilities plan developed.

      Resource and energy recovery should take place at the transfer station or the site of optimum resource and energy recovery.

   b. Transfer facilities will be needed for the metropolitan area of Alameda County (Albany to Hayward) and should be located to efficiently serve collection routes in each area. Such facilities would separate ferrous and nonferrous metals, reusable fibers (wood and paper), glass, and other materials for which adequate markets exist. They would apply the most feasible proven technology to this problem.

c. With respect to resource recovery, industry and the public should be encouraged or required to separate wastes into components which can be sold or reused as secondary materials when it is appropriate as part of the solid waste processing system utilized. (An example of this is waste wood from industries which could be recovered and sold to kraft paper manufacturers.)

d. Adequate attention should be given to waste disposal sites located in or near municipal jurisdictions: Gravel quarries within the Amador-Livermore Valley are not suitable for use as disposal sites because of the potential dangers to groundwater resources.

e. Five-year action programs for 1976-2000 shall be instituted and can provide guides for resource management and capital improvements to the solid waste system.

Scope of Work

The activities which were completed in the development of a medium- and long-term facilities plan are described in the short-term plan. These activities formed the scope of work for this planning. These conditions resulted in a narrow interpretation of the work and led directly into an economic and technical evaluation of waste management facilities. The work was set out in eight tasks which are summarized here.

Task 1 - Data Review. The principal work of this task was to review existing data in the files of the Alameda County Planning Department and to contact the agencies and companies which operate or contract for the operation of facilities. Contact with the agencies and companies during this task was by mailed questionnaire and one meeting involving all agencies and companies.

Task 2 - Inventory and Data Accumulation. Since a policy plan and a short-term facilities plan had recently been developed, the demographic data (population, land use, etc.) from those plans was used as developed by the planning department. Updated data was used where available from the planning department. The inventory included limited field work related to monitoring and observing operations but did not include any waste composition studies or sampling at landfills.

Task 3 - Evaluation and Development of Criteria. This task started the process of developing alternatives which will contain the factors by which decision-makers can make judgments. Storage and collection criteria were identified and opportunities for

improvement were discussed. However, storage and collection facilities design do not appear in the alternatives or the selected program.

Transfer, resource recovery, and disposal facilities and their interactions were evaluated and criteria developed as necessary to analyze the economic, social, environmental, and political aspects of the waste management system.

Specific activities included:

- The establishment of base criteria and costs for the development of waste centers, material movement routes, and transfer stations.
- The establishment of base criteria and costs for resource recovery facilities.
- The establishment of base criteria and costs for energy conversion facilities.
- Market studies undertaken to the degree necessary to update studies already completed (U.C. Berkeley, State of California, etc.).

The final work in this task was the development of financing options for the medium- and long-term facilities. The evaluations leading to the development of financing options covered only the broad range of financing and capital investment factors. Three of the most promising options were documented and used in the evaluation of alternatives for facilities as well as in the specifications of the programs of the final plan.

Task 4 - Development of Alternatives. The solid waste management problems, the potential solutions to those problems, and the criteria for the evaluation of the solutions were grouped to form alternatives. Four alternative facilities programs were identified and descriptions prepared including:

- Technical background (excluding storage and collection)
- Economic comparison
- Environmental, social, and political constraints
- Broad financing, administration, and control factors
- Documentation of alternatives for presentation to the public and public agencies

Task 5 - Meetings With Citizens Committee. The Authority appointed a citizens committee for this planning work. The citizens committee met twice with the consultant during the conduct of work on Tasks 2, 3, and 4. All other citizens committee meetings were held jointly with the Authority subcommittee.

Task 6 - Hearings and Selection of Programs for the Plan. The work in this task included public hearings and agency review of the alternatives. As hearings were completed and programs were finalized, the details were documented for presentation in this final report. The programs include facilities, management and administration as drawn from the alternatives, hearings and reviews. The activities include:

- Presentation of the alternatives at meetings to receive public and public agency comments; three meetings were included in this task.

- Selection of programs from the alternatives.

- Integration of programs into a plan for medium- and long-term facilities.

- Development of a detailed financial program for the final plan.

- Development of an implementation schedule for the programs.

Task 7 - Preparation of Environmental Impact Report (EIR). The EIR, based on selected programs, is an integral part of the final plan. It shall be general and shall cover facility characteristics as opposed to specific sites. The EIR shall comply with the California Environmental Quality Act (CEQA) and Authority guidelines.

Task 8 - Report Preparation. This task involves the accumulation and presentation of all data and evaluations related to decision making for the final programs of the plan.

SHORT-TERM ACTIONS WHICH AFFECT THE MEDIUM- AND LONG-TERM FACILITIES PLAN

The facilities and economic analyses presented herein reflect the short-term actions taken by the Solid Waste Management Authority at their September 7, 1978, meeting. The facilities are a different set than were directed at the August 3, 1978, meeting for the medium- and long-term facilities programs. The economic data presented here can be used to compare these short-term actions with the facilities selected for the medium- and long-term. In the progression of planning activities at some future time, the short-term actions will be integrated with the medium- and long-term facilities.

Location of Facilities

The Authority has directed four new transfer stations to be constructed in the West County area. New transfer stations will be located in Berkeley, at the foot of Davis Street in San Leandro,

and in the Hayward and Fremont areas. These last two stations have been preliminarily located at the Hayward Airport and the Fremont landfill for the purpose of determining the economics of this facility arrangement. Labor intensive resource recovery would take place at each of the transfer stations. A large, central resource recovery facility would be located at the Davis Street transfer station.

Description of Alternative

Solid waste would be collected by the various collectors in Alameda County, and the waste would be hauled in collection vehicles to the various transfer stations. Labor intensive resource recovery would be undertaken at all transfer stations. Waste from all the transfer stations except Berkeley would be delivered to the central resource recovery facility. Products from the processing station would be delivered to the buyers, and the remainder of the material would be landfilled. Any nonprocessible wastes that can easily be separated at the transfer stations would bypass the processing station and go directly to the landfill.

Economic Analyses of Short-Term Action on Transfer Stations

Based on evaluations developed during the production of the medium- and long-term facilities program, labor intensive resource recovery would provide a profit of $0.20/ton of refuse received at the transfer station if the assumed market conditions and recovery rates hold. In addition, a central resource recovery facility would produce a net operating profit of $8.80/ton based on the market assumptions developed in Appendix G of the medium- and long-term facilities program and if RDF is sold at its assumed value. Table 1-1 presents the operating economics for each waste generation area for the short-term action taken by the Authority on September 7, 1978. Supporting data on the economics of the specific transfer station layout voted by the Authority is presented in Appendix N.

The Alameda County Solid Waste Management Authority requested a five-transfer station system be developed for Alameda County. The transfer station system would include the Berkeley transfer station at the proposed maximum capacity of 600 TPD, the Davis Street transfer station at the approved maximum of 2,300 TPD, and the other transfer stations at whatever capacity was most cost-effective. The capacities of the transfer stations are presented in Table 1-2. The total design capacity of 5,000 TPD is based on a 5-day-per-week operation in 1995 with 25 percent excess capacity. The capacity for cost evaluation is based on a 7-day-per-week operation in 1995 with no excess capacity.

The cost of hauling to the transfer stations and from the transfer stations to the landfill are presented in Table 1-3.

Table 1-1. Economics of Facility Plan Adopted by Authority September 7, 1978

Waste generation area	Waste quantity, TPD		Dollars/ton				Total (Cost) or profit, dollars/day	
	1985	1995	Haul cost to transfer station	Haul cost to resource recovery facility	Net revenue from recovered material	(Cost) or profit	1985	1995
Alameda	180	200	2.70	0.0	9.00	6.30	1,130	1,260
Albany	30	30	1.60	0.0	0.20	(1.40)	(40)	(40)
Berkeley	290	330	1.30	0.0	0.20	(1.10)	(320)	(360)
Castro Valley Sanitary District	90	100	2.40	3.40	9.00	3.20	290	320
Dublin-San Ramon Services District	40	60	4.00	3.90	9.00	1.10	40	70
Emeryville	10	10	6.50	0.0	9.00	2.50	30	30
Fremont	310	450	3.20	3.70	9.00	2.10	650	950
Hayward	220	250	1.90	3.40	9.00	3.70	810	930
Livermore	130	180	2.60	3.90	9.00	2.50	330	450
Newark	80	110	4.00	3.70	9.00	1.30	100	140
N. Oakland	370	410	5.00	0.0	9.00	4.00	1,480	1,640
S. Oakland	370	410	2.40	0.0	9.00	6.60	2,440	2,710
Oro Loma Sanitary District	230	250	1.90[a]	1.40[a]	9.00	5.70	1,310	1,430
Piedmont	20	30	5.30	0.0	9.00	3.70	70	110
Pleasanton	80	110	1.20	3.90	9.00	3.90	310	430
San Leandro	90	110	1.10	0.0	9.00	7.90	710	870
Union City	90	130	3.30	3.70	9.00	2.00	180	260
County total	2,630	3,170	-[b]	-[b]	-[b]	-[b]	9,520	11,200

[a]Any cost of hauling waste to and from Davis Street and Hayward facility.

[b]Not applicable.

Table 1-2. Capacity and Location of Transfer Stations in Alameda County

Transfer station	Design capacity[a], TPD	Capacity for cost evaluation[b], TPD	Location
T_1	630	360	Berkeley Transfer Station
T_2	2,300	1,320	Davis Street Transfer Station, San Leandro
T_3	790	450	Hayward Airport, Hayward
T_4	980	560	Durham Road Landfill, Fremont
T_5	300	170	Pleasanton Transfer Station, Pleasanton
Total	5,000	2,860	

[a]Design capacity is on a 5-day/week basis with 25 percent excess capacity.

[b]Capacity is on a 7-day/week basis with no provision for excess capacity.

ORGANIZATION OF THIS DOCUMENT AND THE PROCESS OF APPROVAL

In order to achieve the resource recovery goals of this plan, the components of several waste disposal systems were evaluated. These components included hauling, resource recovery and energy

production. The evaluation of these components resulted in four alternative facilities programs which were evaluated and one of the alternatives was selected with some modifications as the final medium- and long-term facilities plan.

Table 1-3. Total Daily Haul Cost for Waste Disposal, dollars unless noted

Waste generation area	Transfer station[a]	Haul cost to transfer station	Haul cost from transfer station to landfill[c]	Total daily haul cost
Alameda	T_2	540	730	1,270
Albany	T_1	50	170	220
Berkeley	T_1	430	1,850	2,280
Castro Valley Sanitary District	T_3	240	400	640
Dublin-San Ramon Services District	T_5	240	370	610
Emeryville	T_2	70	40	110
Fremont	T_4	1,430	1,870	3,300
Hayward	T_3	480	1,000	1,480
Livermore	-[d]	300[b]	-[d]	300
Newark	T_4	440	480	920
N. Oakland	T_2	2,050	1,500	3,550
S. Oakland	T_2	980	1,500	2,480
Oro Loma Sanitary District	T_2 and T_3	480	900	1,380
Piedmont	T_2	160	110	270
Pleasanton	T_5	130	590	720
San Leandro	T_2	120	400	520
Union City	T_4	430	530	960
County total	-	8,570	12,440	21,010

[a]Transfer Station location indicated in Table 1.

[b]Cost of hauling to East County landfill.

[c]Based on $5.60/ton from Berkeley;
$3.65/ton from Davis St;
$4.00/ton from Hayward Airport.

[d]Not applicable.

Following the plan are a set of appendices which contain descriptions of the steps leading to the alternative programs. The alternative programs are presented in Appendix L. The responses to comments on the draft EIR are contained in Appendix M. Justification for short-term actions affecting the medium- and long-term facilities plan are presented in Appendix N.

It is noted that the short-term facilities plan, the policy plan, the short-term actions and the medium- and long-term facilities are integral parts of the solid waste management plan for Alameda County. These plans and actions will all be integrated in the future.

CHAPTER 2

FACILITIES PLAN

This is the medium- and long-term facilities plan for Alameda County. The facilities include a regionally coordinated system of transfer stations throughout Alameda County with labor-intensive resource recovery efforts at each station, a central, equipment-intensive resource recovery plant, and landfills in the eastern part of the county to which any nonrecoverable or nonmarketable items would be disposed. The facilities are capable of receiving and handling the entire waste stream in Alameda County.

In the next five years in Alameda County, all the landfills now operating in the West County area will be closed. At that time, there will be two landfills which will be in operation. They are both located in the East County area near Livermore. Appendix A of this report and the Alameda County short-term facilities plan contain more information on landfills in Alameda County.

A significant amount of information developed during the formulation of this plan is presented in the appendices of this report. The appropriate appendix should be used for more information as the various facilities are considered in this chapter. This chapter is organized to present:

- The programs which were excluded from the plan.
- Definitions of the planning period.
- Description of the solid waste system.
- Existing plan and policy constraints.
- A summary of alternatives.
- The medium- and long-term facilities programs.

PROGRAMS EXCLUDED FROM THE PLAN

There are programs which are not specifically addressed in this plan which are part of the solid waste system in Alameda County. Three of the most important are collection, source separation and community recycling centers. The collection system has not been evaluated, since any economics or adjustments in the collection

system would not affect the need for the facilities presented herein. Historically, source separation programs have not seriously affected the quantities of wastes which must be collected, processed, and disposed.

Community recycling centers have been in operation for more than five years in Alameda County. These centers have increased in number and size as citizen and business support increased. These centers function as locations where citizens can bring material for recycling and, thus, assist in source separation efforts. A summary of these projects is presented in the Solid Waste Management Plan for Alameda County. The largest recycler in Alameda County is located in Berkeley and recycles approximately three percent of Berkeley's solid waste.

Source separation is considered the best technique currently available for recovering paper products for reuse as fiber feedstock to produce recycled paper and cellulose insulation. However, recovery rates are generally very low in source separation programs (10 to 15 percent), and successful programs may require legislation and intensive public education programs. These are policy decisions which are appropriate to the policy plan, not this facilities plan.

A final note regarding programs not covered herein concerns the administrative responsibility of the Authority versus local agency responsibility. The three program areas--collection, source separation, and community recycling centers--are the responsibility of local agencies. Each program, by definition, implies local community action. The Authority has a passive role in these programs.

DEFINITION OF MEDIUM- AND LONG-TERM PLANNING PERIODS

For the purposes of this plan, 1995 has been taken as the appropriate year for the evaluation of long-term facilities, and 1985 has been taken as the appropriate year for the evaluation of medium-term facilities. These specific years were selected to aid in the evaluation of facility size and cost-effectiveness.

Alameda County has an adopted short-term facilities plan which covers the years to 1980. Thus, implementation of facilities discussed in this plan is assumed to have occurred prior to 1980 if cost-effective.

There are a number of programs which are part of solid waste management in Alameda County but are not discussed in this chapter. These programs include the management of hazardous waste, including infectious and radioactive materials, water and wastewater treatment plant sludges, demolition wastes and industrial wastes and litter. Most of the programs to handle these wastes are under the jurisdiction of other public agencies or they do

not significantly impact the solid waste stream considered in developing these alternatives. The industrial wastes are primarily recycled to other producers and thus do not reach the waste stream considered here. Demolition waste quantities, however, are significant and might present a problem of such magnitude that if adequate disposal sites in the West County areas are not found, illegal dumping may become a problem. Similarly, there are no Class I (hazardous waste) disposal sites in Alameda County. Locating a Class I disposal site, either in or nearby the county, would provide for adequate disposal capacity for these wastes generated in Alameda County. More information on these waste programs is presented in Appendix A.

SOLID WASTE SYSTEM IN ALAMEDA COUNTY

There are 16 agencies in Alameda County which have the responsibility to provide, or contract for, the collection and disposal of solid waste in Alameda County. Twelve of these agencies have franchise agreements with the Oakland Scavenger Company. The cities of Berkeley and San Leandro provide their own collection and disposal services, the City of Pleasanton contracts for collection and disposal with the Pleasanton Collection Service, while the City of Alameda provides its own disposal while contracting with Alameda City Disposal Service for collection.

Table A-11 contains a definitive list of the waste collectors and disposers for each agency in Alameda County. There are currently six landfills operating in Alameda County and one new landfill which is intended to be opened in 1979. Of the six operating landfills, one has reached capacity, one will be closed by the end of 1978, one will close in 1979 unless an extension, which is being sought, is granted, and two will close by 1982. These landfills are all located along the shore of San Francisco Bay. The only two landfills which will operate after 1982 are the East County landfill located on Vasco Road approximately two miles north of Interstate Highway 580, and the Altamont landfill, still to be opened, which is located approximately three miles northeast of the intersection of Altamont Pass Road and Interstate Highway 580.

The imminent closure of the West County landfills necessitates the construction of facilities to replace them. These facilities are addressed in this medium- and long-term facilities plan.

Waste Generation Areas

In order that the 16 agencies responsible for handling solid waste in Alameda County can review and comment on the facilities program as it pertains to them, each of the agencies was assumed to constitute a "waste generation" area (see Appendix B for a definition of waste generation areas). The costs of the facilities are presented, to the fullest extent possible, for

each waste generation area to simplify the evaluation of the impact on each agency. Data on the population in and quantities of solid waste generated by each waste generation area are presented in Appendices B and C.

EXISTING PLAN AND POLICY CONSTRAINTS

Certain assumptions were made during the development of the facilities plan that have significant impact on its content and in the interpretation of the programs. These assumptions are highlighted here to provide the background needed to understand the approach and methodology used in developing the plan.

Baling to Increase Density

The possibility of extending the life of existing landfills by increasing the density of the solid waste by baling or the utilization of more compaction equipment was not considered. The life of the existing landfills is so short that extension of the landfill operation by these methods would not significantly affect the need for the medium- and long-term facilities.

Data from the Short-Term Plan

The short-term facilities plan for Alameda County included a suggested outline for the medium- and long-term facilities plan. The order of that outline was not followed since the outline included mandates that facilities be implemented by certain dates regardless of their cost-effectiveness at the time. The outline also included a mandated approach to the selection of required facilities, i.e., that transfer stations and resource recovery facilities would be included regardless of the economics or other factors which might be involved. This also was considered to be too constraining for a viable community plan for medium- and long-term facilities and hence was not followed. However, the essence of that outline as it was interpreted here is presented in the alternatives.

Interpretation of Goals from the Policy Plan

Similarly, there are a number of statements in the policy plan which were not followed in the development of the alternatives since they were felt to be too constraining or unrealistic. These statements are listed below:

- "The first priority alternative for the 1980-1990 planning period is Alternative 1990-C which is a full-scale material and energy recovery system to achieve 92 percent resource recovery. The system would include two full-scale processing/energy recovery facilities, and wastes from all four planning units would be processed. This system represents the optimum goal; many hurdles remain in the interim." Page I-4, Reference 1.

- "Transfer facilities will be needed for the metropolitan area of Alameda County (Albany to Hayward) and should be located to efficiently serve collection routes in each area. Such facilities would separate ferrous and nonferrous metals, reusable fibers (wood and paper), glass and other materials for which adequate markets exist. They would apply the most feasible proven technology to this program." Page I-10, Reference 1.

- "In view of the vast virgin resources and low cullet value, glass recycling appears neither likely to 'carry its own weight' nor be of great importance in terms of resource conservation." Page VIII-9, Reference 1.

- "If maximum conservation of resources (including energy) is a primary goal, then materials in solid waste should be recovered through composting rather than converted to energy." Page VIII-21, Reference 1.

- "Industry and individual companies should be encouraged to recover and revise their own waste products through legal sanctions." Page VIII-21, Reference 1.

These statements were felt to constrain the development of the facilities plan and, thus, were not explicitly followed in plan development.

SUMMARY OF ALTERNATIVE PROGRAMS

The alternative facilities programs are summarized below. Detailed explanations of the alternatives are presented in Appendix L. The facilities program does not evaluate any current proposals and is not intended to be site specific. Therefore, the community constraints and specific problems associated with sites, transportation routes, etc., are not presented since they are not now known. The short-term actions taken by the Alameda County Solid Waste Management Authority at their September 7, 1978, meeting are included in Chapter 1 of this report. Those facilities are a different set than the facilities selected for the medium- and long-term facilities presented in this chapter. In the progression of planning activities at some future time, the short-term actions will be integrated with the medium- and long-term facilities.

Alternative 1 - Direct Long Haul by Collection Vehicles

In this alternative, collection vehicles would carry wastes from the end of the collection routes in the various waste generation areas directly over highways to landfills in East County. Due to the closure of landfills in West County before 1980, this alternative is essentially a "no action" alternative.

Alternative 2 - Indirect Long Haul Through Transfer Stations

This alternative includes transfer and transportation facilities which would receive wastes from collection vehicles, transfer these wastes to larger capacity vehicles, and then transport the wastes to disposal sites. Transfer stations in the West County area are a more economical means of completing the long haul of refuse to the East County landfills than direct long haul by collection vehicles.

Alternative 3 - Recovery of Materials from Solid Waste

This alternative includes the facilities necessary to initiate large-scale resource recovery of material from the solid waste stream. The facilities are capable of receiving and handling the entire waste stream in Alameda County. An evaluation of the cost-effectiveness of large capacity plants versus smaller plants is presented in Appendix H. The evaluation indicates that the most cost-effective facility for Alameda County is a single, large plant.

Alternative 4 - Materials Recovery and Energy Production

This alternative contains the programs for facilities that would ensure a market for the energy products which might be derived from solid wastes. Based on an evaluation of potential energy markets presented in Appendix G and an evaluation of potential energy processes in Appendix I, electricity was selected as the most marketable and cost-effective energy product for Alameda County.

MEDIUM- AND LONG-TERM FACILITIES PROGRAM FOR ALAMEDA COUNTY

The facilities include a regionally coordinated system of transfer stations throughout Alameda County with labor-intensive resource recovery efforts at each station, a central, equipment-intensive resource recovery plant, and landfills in the eastern part of the county to which any nonrecoverable or nonmarketable items would be disposed. The facilities are capable of receiving and handling the entire waste stream in Alameda County. An evaluation of the cost-effectiveness of large capacity resource recovery plants versus smaller plants and the evaluation of labor intensive resource recovery is presented in Appendix H. The evaluation indicates that the most cost-effective facility for Alameda County is a single, large plant. If smaller facilities are shown to be cost-effective, they may be included in the plan.

Description of Program

Solid waste would be collected by the various collectors in Alameda County, and the waste would be hauled in the collection

vehicles to transfer stations in Alameda County. Efforts would be undertaken at each transfer station for labor intensive resource recovery. Wastes from the transfer stations would be delivered to one central processing station. Products from the processing station would be delivered to the buyers and the remainder of material would be landfilled. Any nonprocessible wastes that can be easily separated at the transfer stations would bypass the processing station and go directly to the landfill. The general location of facilities is shown on Figure 2-1. The resource recovery facility analysis for various size facilities is presented in Appendix H. The market analysis for recovered materials is presented in Appendix G.

Transfer Stations

Wastes would be hauled to local transfer stations in various types of vehicles and would be transferred to long-haul transfer vehicles. The transfer stations are described below:

- North Oakland transfer station, located in the vicinity of the intersections of Highways 17, 580 and 80 with a capacity of 810 tons/day on a 7-day/week basis.

- South Oakland transfer station, generally located in the vicinity of the Oakland Coliseum with a capacity of 610 tons/day on a 7-day/week basis.

- Hayward transfer station, generally located in the vicinity of the Hayward Airport with a daily capacity of 840 tons/ day on a 7-day/week basis.

- Fremont transfer station, generally located in the vicinity of the Durham Road landfill with a capacity of 560 tons/day on a 7-day/week basis.

- Pleasanton transfer station, an existing facility with an expanded daily capacity of 350 tons/day on a 7-day/week basis.

All capacities are based on the estimated amounts of residential, commercial and light industrial wastes generated within the county in 1995. Efforts would be undertaken at each transfer station for labor-intensive resource recovery.

Resource Recovery Plant

Transfer vehicles would haul collected refuse to a central resource recovery facility. The facility could be placed at any north or central county site but is considered to be located at the South Oakland transfer station to simplify the economic analysis. The resource recovery facility is only cost-effective if a market is found for the refuse-derived fuel (RDF). The economic analysis

and management and financing discussion assume that a market is available for RDF and that the RDF is sold to a customer other than the operation of the resource recovery facility. Based on the costs and revenues developed for the 3,300 TPD resource recovery facility in Appendix H, the net operating cost or profit of each module was determined and is summarized in Table 2-1.

By combining the values in Table 2-1, a net operating profit of $8.80 per ton, which includes the cost of disposing of any residue, can be made if the market assumptions used in Appendix G remain valid and a market is developed for RDF. Labor intensive resource recovery at the transfer stations will add an additional profit of $0.20 per ton. The evaluation of the cost-effectiveness of labor intensive resource recovery is presented in Appendix H.

Table 2-1. Economic Feasibility of Each Module in the 3,300 TPD Resource Recovery Facility

Module	Net operating (cost) or profit/ton, dollars/ton
Reduction, ferrous and support	(6.51)
Refuse derived fuel	12.40
Heavy product separation	(0.74)
Aluminum	1.85
Glass	1.80

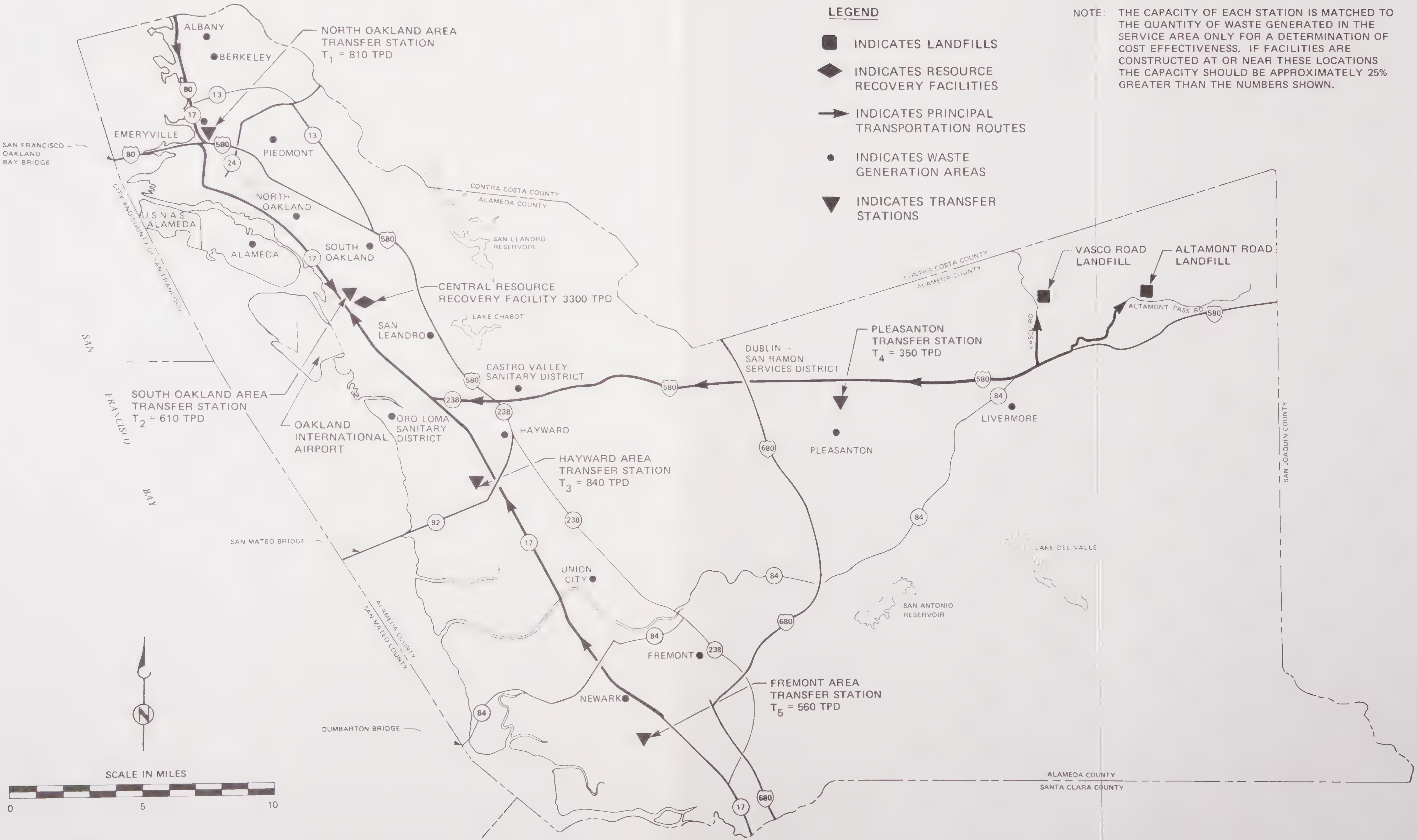
Table 2-2 presents the operating economics for resource recovery facilities for each waste generation area for one central plant in Alameda County with a market for RDF.

Capital costs for the facilities described herein would be approximately $35 million dollars. The expected profits and capital and operating costs result in an average annual return per account of approximately $13 in 1995 if a market for RDF is found. Assuming an average 2-can garbage collection service bill of $5 per month ($60 per year) in 1977, this cost/profit for recovery of materials would result in a 22 percent decrease in cost over existing service in Alameda County in 1995 if an RDF market exists.

Timing of Facilities. The construction of the resource recovery facility should coincide with the completion of the construction of the transfer stations. This would be in approximately 1981 or 1982. This construction sequence also coincides with the projected development of the proposed generating facility for the City of Alameda which would provide a market for the RDF produced by the resource recovery facility. Any market for RDF will greatly reduce the need for landfill capacity for solid waste in Alameda County.

MANAGEMENT AND FINANCING

The medium- and long-term facilities will be managed and financed in the following manner:



BROWN AND CALDWELL
CONSULTING ENGINEERS
WALNUT CREEK, CALIFORNIA

Fig. 2-1 Location of Facilities for Medium and Long-Term Solid Waste Facilities Program for Alameda County

Facility	Method of Managing	Method of Financing
Transfer stations		
North Oakland	Public or private	Public
South Oakland	Private	Public
Hayward	Private	Public
Fremont	Private	Public
Pleasanton	Private	Public
Resource recovery		
Facility	Public or private	Public or private

Management and financing for the short-term facilities is not a part of this plan but do appear in the Solid Waste Management Plan and the Solid Waste Management Facilities Plan for Alameda County.

Table 2-2. Economics of Medium and Long-Term Solid Waste Facilities Program for Alameda County

Waste generation area	Waste quantity, TPD[a]		Haul cost to transfer station[b]	Dollars/ton			Total (cost) or profit, dollars/day	
	1985	1995		Haul cost to resource recovery facility[c]	Net revenue from recovered materials[d]	Total (cost) or profit	1985	1995
Alameda	180	200	1.75	0.0	9.00	7.25	1,310	1,450
Albany	30	30	3.25	2.20	9.00	3.55	110	110
Berkeley	290	330	1.75	2.20	9.00	5.05	1,460	1,670
Castro Valley Sanitary District	90	100	2.50	2.30	9.00	4.20	380	420
Dublin-San Ramon Services District	40	60	4.25	4.10	9.00	0.65	30	40
Emeryville	10	10	1.00	2.20	9.00	5.80	60	60
Fremont	310	450	1.00	3.90	9.00	4.10	1,270	1,850
Hayward	220	250	1.50	2.30	9.00	5.20	1,140	1,300
Livermore	130	180	2.60	4.10	9.00	2.30	300	580
Newark	80	110	4.00	3.90	9.00	1.10	90	120
North Oakland	370	410	1.75	2.20	9.00	5.05	1,870	2,070
South Oakland	370	410	1.00	0.0	9.00	8.00	2,960	3,280
Oro Loma Sanitary District	230	250	1.25	2.30	9.00	5.45	1,250	1,360
Piedmont	20	30	1.75	2.20	9.00	5.05	100	150
Pleasanton	80	110	1.50	4.10	9.00	2.40	190	260
San Leandro	90	110	2.75	2.30	9.00	2.95	270	320
Union City	90	130	3.50	2.30	9.00	3.20	290	420
County total	2,630	3,170	N.A.	N.A.	N.A.	N.A.	13,080	15,580

[a]Based on Table C-3.

[b]From Table 2-4.

[c]Based on haul costs of:
$2.20/tons from T_1
$0.0/tons from T_2
$2.30/tons from T_3
$4.10/tons from T_4
$3.90/tons from T_5

[d]Includes the cost of disposal.

Transfer Stations

Transfer station activities are defined as transfer, resource recovery at the transfer station (labor intensive and/or equipment intensive) and haul to a central resource recovery facility. The

costs/benefits associated with these transfer station activities will be combined (allocated on the basis of tonnage) with the collection costs associated with each service area from which the transfer station receives wastes and itemized in the bills to each customer. The subregional costs and method of allocation are itemized below; these activities should remain separate in all accounting procedures:

Cost Causing Activity	Method of Allocation
Collection	As determined by collector with approval of local agency.
Transfer	Allocated to each collection service area (and subsequently to each customer) tributary to the transfer station by tonnage.

Because both collection costs and transfer station costs are expected to be different for each collection service area and transfer station, respectively, rates for these elements of service are expected to be nonuniform throughout the region.

Central Resource Recovery Facilities

The central resource recovery facility will be either publicly or privately managed and financed. These facilities will be considered regional facilities. Under private ownership, the costs associated with these facilities (for rate-making purposes) will be taxes and the operating and maintenance costs. The operator will earn a rate of return on rate base (assets employed to provide service) as determined by the Alameda County Solid Waste Management Authority. Included in rate base will be the resource recovery facilities.

It is recommended that revenues in excess of those necessary to allow the operator to earn the recommended rate of return on the rate base be allocated back to customers through the subregional transfer station operations on the following basis:

- First, excess revenues should be allocated back to each transfer station in an attempt to equalize any cost differentials resulting from the subregionalization of the transfer station operation.
- Second, after the above allocation, any additional excess revenues should be further allocated back to each transfer station cost center via their pro rata contribution to tonnage.

Under public ownership, the costs associated with operation of the facilities will consist of operating and maintenance costs and debt service requirements. Revenues in excess of those required to

fund operating and maintenance costs and debt service will be allocated back to the customers in the same manner as set forth above for the case of private ownership.

The above allocation procedure is consistent with the purpose of regionalization, that is, the cost savings resulting from regionalization are allocated to all customers in an equitable manner. The separate accounting practices for collection, transfer, resource recovery and disposal will insure equitable cost allocation throughout Alameda County.

APPENDICES

APPENDICES

CONTENTS

APPENDICES - CONTENTS (continued)

APPENDICES - CONTENTS (continued)

APPENDICES - CONTENTS (continued)

APPENDICES - CONTENTS (continued)

APPENDICES - CONTENTS (continued)

LIST OF TABLES

APPENDICES

APPENDICES - LIST OF TABLES (continued)

APPENDICES - LIST OF TABLES (continued)

APPENDICES - LIST OF TABLES (continued)

APPENDICES - LIST OF TABLES (continued)

APPENDICES

LIST OF FIGURES

*Foldout figures follow page number noted.

APPENDICES - LIST OF FIGURES (continued)

*Foldout figures follow page number noted.

APPENDIX A

SPECIAL WASTES AND OTHER FACTORS AFFECTING THE MEDIUM- AND LONG-RANGE FACILITIES PLAN

APPENDIX A

SPECIAL WASTES AND OTHER FACTORS AFFECTING THE MEDIUM- AND LONG-RANGE FACILITIES PLAN

Special wastes require collection, processing, and disposal procedures other than those normally used for municipal solid wastes. This appendix describes the status, as it relates to Alameda County, of the solid waste management programs for hazardous waste, litter, demolition waste, water and wastewater treatment plant sludges, and industrial wastes. Wastes contributing to each category are described, estimates are made of 1977 quantities, and projections are developed for 1985 and 1995. Collection and storage facilities are discussed in terms of current availability and future needs.

The development of systems for managing these wastes is not an objective of this study. Other agencies with administrative and management responsibilities will undertake system development. For Alameda County these other agencies include:

- Alameda County Agricultural Commissioner--responsible for hazardous agricultural wastes.
- State Department of Health--responsible for hazardous wastes.
- State Water Resources Control Board--responsible for water pollution control.
- State Solid Waste Management Board--responsible for litter programs.
- California Regional Water Quality Control Board--responsible within its region for adoption and enforcement of waste discharge requirements for all waste disposal that could potentially affect water quality.

Each agency is presently working on program definitions and implementation strategies. The Alameda County Solid Waste Management Authority should maintain contact with these agencies and provide support where necessary to ensure that the waste quantities identified herein are properly managed.

HAZARDOUS WASTES

The State Department of Health defines hazardous waste as a waste or a combination of wastes "which because of its quantity, concentration, or physical, chemical or infectious characteristics may either:

(a) Cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness.

(b) Pose a substantial present or potential hazard to human health or environment when improperly treated, stored, transported, or disposed of, or otherwise managed."[1]

Damage to human health may occur as a result of direct skin contact, inhalation or ingestion of either the waste material or its derivatives. Damage to the environment may entail damage to living organisms by the same means or may involve contamination of man-made structures, soils, and surface and groundwaters such as to prevent the normal use of these resources. Consequently, hazardous wastes require special handling and disposal techniques to ensure containment.

Materials such as industrial waste chemicals and sludges, pesticides, radioactive wastes, and infectious wastes are considered to be hazardous. A list of more than 800 hazardous materials is contained within the State Department of Health Hazardous Waste Regulations.[2] This list does not address radioactive or infectious wastes and pertains mainly to chemicals used and generated within the industrial, laboratory and agricultural spheres. The hazards associated with any waste material are dependent on the characteristics of the chemical constituent, including toxicity, corrosiveness, sensitizing capability, flammability and pressure-generating capability.

Table A-1 shows the principal agencies, legislation and regulations for each hazardous waste category.

Industrial Hazardous Wastes

Industry in Alameda County produces a variety of hazardous wastes including organic and inorganic acids, caustics, pesticides, paint sludges and oils, and mixtures of these and other chemicals.

A survey of those industries determined to be generating the bulk of the hazardous wastes was recently completed by the county.[3] The objective of the study was to establish types and quantities of wastes generated to facilitate future reclamation and disposal

Table A-1 Principal Agencies and Controls for Hazardous Waste Handling and Disposal

Hazardous waste	Principal agencies	Principal legislation and regulations
Industrial waste	State Department of Health	Hazardous Waste Regulations, Title 22, Division 4
		Health and Safety Code, Division 20, Chapter 6.5
	State Water Resources Control Board	California Water Code Division 7
	California Regional Water Quality Control Boards	California Administration Code Title 23, Chapter 3, Subchapter 15
Pesticide containers	State Department of Food and Agriculture	California Administrative Code, Title 3, Chapter 4, Section 3141, 3142
	Alameda County Department of Agriculture	
Radioactive waste	U.S. Department of Energy	Atomic Energy Act, 1954 (as amended)
	U.S. Department of Transportation	Code of Federal Regulations, Volume 49, 100-199
	State Department of Health	California Administrative Code, Title 17
Infectious waste	State Department of Health	California Administrative Code, Title 17
	Alameda County Health Care Services Agency	California State Health and Safety Code, Division 20, Chapter 6.5

programs. In most cases the data collected represented estimates rather than actual measurements of present quantities. Few respondents were able to estimate future quantities of waste.

Compilation of data contained in the county report indicates that hazardous industrial waste in the county is generated at an annual rate of more than 5 mil gal. Approximately 10 percent (500,000 gal) of this waste material is reclaimed. High recovery rates are obtained with organic acid wastes (more than 90 percent of the 30,000 gal generated is recovered) and waste oil (more than 70 percent of the 80,000 gal generated is recovered). Of the remaining 4.5 mil gal of hazardous waste, at least 90 percent is disposed to Class I sanitary landfill sites (as required by the State Administrative Code).[4] Almost 9 percent of the remaining disposable waste is held in tanks or evaporating ponds or is disposed to the sewer system after pretreatment. Indiscriminate disposal to surface waters and Class II landfill sites does occur although the survey indicates that the quantities involved may be less than 1,000 gallons per year.

The volume of hazardous industrial waste requiring disposal in the future depends on the growth of the industrial sector in Alameda County and the success of efforts to recycle, reclaim and reuse industrial waste. Based on a static 10 percent recovery efficiency and an increase in hazardous waste generation proportional to the projected population growth of the county (see Table B-3), projections have been made for industrial hazardous waste quantities in 1985 and 1995. These projections are shown in Table A-2.

The cumulative volume of hazardous waste requiring disposal between 1977 and 1985 is approximately 38 mil gal. Between 1985 and 1995, the disposal of 52 mil gal will be required based on the above assumptions.

Since most nonrecoverable industrial hazardous wastes are noncombustible and nonbiodegradable, disposal at Class I sanitary landfill sites is likely to remain the method of disposal. Since there are no Class I sites in Alameda County at the present time, hazardous industrial wastes will continue to be disposed at sites outside the county, the most significant sites being the IT Corporation of Solano County site at Benicia the IT Corporation of Contra Costa County site at Martinez and the Sanitary Landfill Class I site at Richmond. Although these three sites are each estimated to have a lifespan of from 5 to 20 years, closure of either site would seriously affect the future of continued disposal of hazardous wastes from Alameda County at these sites. Consequently, possible Class I sites within the county need to be identified for future development.

Table A-2. Industrial Hazardous Waste Projections

Waste classification	Estimated annual waste volumes, gallons		
	1977	1985	1995
Industrial waste generated	5,000,000	5,430,000	6,000,000
Industrial waste recycled	500,000	543,000	600,000
Industrial waste disposed	4,500,000	4,887,000	5,400,000

Table A-3. Management of Industrial Hazardous Wastes in Alameda County

Responsible agencies	Programs
State Department of Health	Principal agency, sets standards and regulations for hazardous waste storage, handling, collection, transportation and disposal.
California State Solid Waste Management Board	Reviews county hazardous waste management programs, studies disposal of hazardous waste.
California Highway Patrol California Department of Transportation	Develops procedures for the transportation of hazardous wastes and the management of hazardous waste spills.
Department of Industrial Relations, Division of Industrial Safety	Reviews chemical waste storage and handling.

Table A-3 presents the principal agencies and programs associated with industrial hazardous waste management in Alameda County. Since there are no Class I sites or processing facilities in the county, air and water pollution control agencies have been omitted. There is no direct county control over current collection, transport and disposal practices for hazardous industrial wastes.

Pesticides

Since it is the pesticide containers, not the liquid pesticides, that enter the solid waste stream, this discussion is limited to containers only. The California Department of Food and Agriculture includes all insecticides, rodenticides, spray adjuvants, plant growth regulators, fungicides, and herbicides within the pesticide classification.[5,6] Hence, by this definition "pesticide containers" are containers which are used to hold the above range of chemicals and represent a component of the hazardous waste stream.

Pesticide containers vary in size from 5 gal or less to 55 gal drums. Metal drums of the 55 gal size and sometimes the 30 gal size are usually returned to a distributor or drum reconditioner for reuse. Disposable containers are generally of 1 to 5 gal capacity.

Due to the health and safety threat which the improper disposal of pesticide containers represents, disposal must comply with the regulations of the State Department of Food and Agriculture. The State Department of Food and Agriculture regulations state that pesticide containers must either be:

- left unrinsed and subsequently disposed at a Class I site
- rinsed immediately after use with subsequent disposal at a Class II landfill site, the procedure being in accordance with established procedures
- or burned in the field immediately after use under a BAAPCD permit.

In Alameda County the predominant method of disposal is by rinsing and Class II disposal. The Alameda County Agricultural Commissioners' Office has established specific procedures to comply with state regulations. Disposal at Class II sites (Davis St., Turk Island and Vasco Road) is permitted on the first Tuesday of each month only. Containers must be rinsed and drained three times before being accepted. Testing of a representative sample of containers is carried out by an Alameda County Agricultural Commission inspector to ensure compliance with the regulations.

The number of pesticide containers currently disposed at landfill sites in Alameda County has been estimated at 1,000 per month.[8] Due to the effects of the recent drought and a continuing uptake of agricultural land by urban development, a downturn in the production of field crops in the county has occurred.[7] Accordingly, the Alameda County Agricultural Office expects registered pesticide usage to decline over the next five years. Other factors contributing to this decrease in usage include an increase in effectiveness of newer types of pesticides and less indiscriminate pesticide application due to the need to apply for a permit as more pesticides are placed on the restricted list. Consequently it is expected that the number of pesticide containers requiring disposal in 1985 and 1995 is not likely to exceed 1977 levels. The future disposal of pesticide containers should not demand increased managerial and labor involvement, nor should pesticide containers contribute a significant volume of material to the total solid waste stream.

Radioactive Wastes

There are more than 67 medical, industrial and commercial establishments in Alameda County which use redioactive materials. Hospital and medical facilities use primarily short-lived radioisotope materials with half-lives from one-half hour to 15 days. Approximately 80 percent of the material utilized is technetium 99 which has a 6-hr half-life. The handling and disposal of these materials is controlled by the California Administrative Code (CAC), Title 17. The waste radioactive material can be disposed to the sewer if the diluted material does not have a radioactivity level exceeding normal drinking water levels, or as is more common, the waste is stored and the radioactivity allowed to decay to nonhazardous levels (usually less than one month storage required) and disposed of as part of the infectious waste stream.

Long-life radioisotopic waste materials are generated by Lawrence Livermore Laboratory, Lawrence Berkeley Laboratory and the University of California. Small quantities are also generated at hospitals and clinics. This material is collected by commercial radioactive waste collection companies and is transported to Nevada for disposal. The handling and disposal procedures are according to federal regulations.[12]

No quantitative data is available on the wastes emanating from Lawrence Livermore Laboratory although relative to other sources both the volume and radioactivity would be substantial. Lawrence Berkeley Laboratory reports a "relatively small" quantity. The University of California at Berkeley's Radiation Safety Office reports that 2100 cu ft of dry radioactive waste was disposed by the University in the 12 months ending mid-1977. The university expects to increase waste volumes by about 10 percent per year.

Due to a lack of information on Lawrence Livermore's output, an estimate of current and future radioactive waste volumes for the county cannot be made.

Short-lived radioactive material which has been stored until monitoring indicates it has a "safe" level of radioactivity will have minimal impact on the total solid waste volumes and modes of handling and disposal, providing procedures are in accordance with the CAC (Title 17). The handling, transport, and disposal of long-life radioactive material is carried out under federal regulations. Since the handling and transport of significant volumes of this material occurs within the county, the county should be aware of current procedures and be satisfied with the precautions taken to ensure public safety.

Infectious Waste

Infectious waste is defined as:

(a) Pathological specimens, tissues, specimens of blood elements, excreta or secretions and disposable articles attendant thereto from humans or animals at a hospital, medical clinic, research center, veterinary institution, or pathology laboratory.

(b) Surgical operating room pathologic specimens and disposable articles attendant thereto which may harbor or transmit pathogenic organisms.

(c) Pathologic specimens and disposable articles attendant thereto from outpatient areas and emergency rooms.

(d) Discarded equipment, instruments, utensils and other articles which may harbor or transmit pathogenic organisms from the rooms of patient with suspected or diagnosed communicable disease.

Alameda County has more than 1,500 establishments engaged in medical and health services. Of these, the general acute (GA) hospitals, the skilled nursing (SN) facilities and the intensive care (IC) facilities are considered to produce 90 percent of the infectious wastes. Communications with a number of these facilities indicated that infectious waste volumes varied widely depending on such factors as the presence of specialized facilities, staff-to-patient ratios, the extent to which disposable products are used, and the degree of infectious waste segregation. Less than 0.5 cu yd/week to more than 3 cu yd/day of infectious waste were reported. The most common waste volume reported was 3-4 cu yd per week for a facility of about 200 patients.

Since comprehensive data on present infectious waste volumes in Alameda County are not available, present and future infectious waste volumes have been estimated based on an average production of 2 cu yd per 100 patients per week for the GA, SN and IC facilities. On this basis, Table A-4 indicates that the present infectious waste volume in Alameda County is approximately 170 cu yd/week. As no overall growth is expected between 1977 and 1995 in the use of these facilities in the county, it has been estimated that future infectious waste volumes will remain at present levels.

The provisions for handling, storage and disposal of infectious waste are set forth in the CAC guidelines, and procedures have been developed by the Task Force on Medical Services Waste Disposal[19] and county health service agencies. In Alameda County, procedures for infectious waste handling and disposal (other than by incineration on site) must be in accordance with the CAC provisions and must be approved by the Health Care Services Agency. All infectious wastes transported from the medical or hospital facility is to be sealed, containerized, marked and transported in an enclosed vehicle directly to the disposal site. No compaction or mixing with other refuse is allowed.

Since BAAPCD has stringent air quality requirements which discourage on-site incineration, infectious wastes generated in the county are primarily disposed either by incineration by Therm-Tec, a private contractor in Emeryville, or by landfill. Therm-Tec currently incinerates about 2,000 lb/day of infectious waste from both Contra Costa and Alameda Counties. Disposal at Class II landfill sites is undertaken by collection agencies. "Disposal of infectious wastes by landfill should entail separate handling and should be undertaken immediately upon arrival at the site."[19]

The waste volumes presented in Table A-4 are relatively small with respect to the overall solid waste stream. Thus, infectious waste volumes will not be a significant factor in the planning of solid waste disposal facilities. The Alameda County Health Department will probably continue to manage the disposal of infectious materials.

Summary of Hazardous Wastes

State agencies regulate the handling and disposal of all hazardous wastes with the exception of long-life radioactive materials, which come under the jurisdiction of the federal government. Industrial hazardous waste regulations are administered by state agencies. The regulations associated with the disposal of pesticide containers in sanitary landfills are administered by the county agricultural department. The regulations associated with disposal of infectious wastes are administered by the County Health Department.

Table A-4. Existing and Projected Bed Data and Infectious Waste Volumes for General Acute, Skilled Nursing and Intensive Care Facilities

Year	Number of beds		Occupancy rate, percent	Average number of beds occupied	Estimated infectious waste volume, yd^3/week
	Licensed	Existing			
1977	11,517	10,631	81	8,611	172
1985	-	9,458	85	8,039	160
1995	-	9,984	85	8,486	170

Source: Hospital Services Agency for Alameda and Contra Costa Counties and Brown and Caldwell.

Current practices associated with the handling and disposal of hazardous wastes appear to be satisfactory although those associated with infectious and radioactive wastes need to be studied in more depth.

Recommendations for Hazardous Waste Management

A Class I disposal site is needed in the county. Existing sites are outside the county and have a projected operational life dependent on continued public acceptance and the development of recycling technology. The development of a Class I site in the county would reduce hauling distances, ensure Class I site availability and reduce the load on existing sites.

LITTER

The Litter Control, Recycling and Resource Recovery Act of 1977[12] defines litter as "all improperly discarded waste material including, but not limited to, convenience food, beverage and other product packages or containers constructed of steel, aluminum, glass, paper, plastic and other natural synthetic materials, thrown or deposited on the lands and waters of the state, but not including the properly discarded waste of the primary processing of agriculture, mining, logging, sawmilling, or manufacturing." Litter is a potential threat to public health, safety and welfare and adversely affects general aesthetics and community self-image.

A summary of a survey conducted in January 1978 of agencies in Alameda County on the litter problem is presented in Table A-5. No serious litter problem was identified by any of the agencies that were contacted.

Responsible Agencies and Abatement Programs

Government agencies involved in litter management in Alameda County are the State Division of Highways (Cal-Trans), the California Highway Patrol, the County Sheriff's Office, County Road Department, the County Health Department, the East Bay Regional Parks District, and public works agencies and police departments in the 13 cities.

There is no existing comprehensive county-wide program to abate litter. State, regional, county and city agencies each operate separate litter control programs. A summary of agencies and programs is shown in Table A-6.

Table A-5. Regional Assessment of the Litter Problem

Regional agency	Litter problem assessment
Alameda	No litter problem
Albany	Normal amount of debris in commercial area particularly around "fast food" establishments and at bus stops nearest those establishments.
Berkeley	City wide litter problem. Specifically litter accumulates along Telegraph Avenue, Shattuck Avenue, University Avenue, Sacramento Street, from Ashby to University Avenue, the Bay front and the business district.
Castro Valley Sanitary District	No litter problem
Dublin-San Ramon Services District	Some litter evident. Litter accumulates at small shopping center at NW corner of intersection of Village Parkway and Amador Boulevard in Dublin.
Emeryville	No response
Fremont	Serious problems; concentrated on junior high and high school lands as well as on Durham Road from Hwy 17 west to the Durham Road landfill. Negligent transport of refuse by public largely responsible for litter on Durham Road.
Hayward	Some littering occurs. Loose litter tends to blow along Mission Boulevard toward Tennyson.
Livermore	No litter problem
Newark	Most noticable areas of litter accumulation are along flood control channels on Lido Boulevard between Cedar Boulevard and Jarvis Avenue, at the rear of the Lido Faire Shopping Center, on the section of Willow Road between Thornton Avenue and Cedar Boulevard extended, and portions of the Hetch Hetchy right-of-way between Nimitz Freeway and Filbert Street.
Oakland	Litter is a problem
Oro Loma Sanitary District	Littering occurs, particularly at the north end of Railroad Avenue off Bockman Road, adjacent to Southern Pacific Railroad tracks.
Piedmont	Minor littering, no pattern to distribution.
Pleasanton	Minor littering; major litter problem on access road to City's transfer station.
San Leandro	Some littering occurs. Litter is generally dumped on vacant lots and ends of dead-end streets or cul de sacs and industrial area streets.
Union City	Litter is present. Accumulates on Dyer Street and Union City Boulevard (near Turk Island Dump), Smith Street and Union City Boulevard (near paper recycler) and along open flood control channels and unimproved city streets.

Table A-6. Litter Control Programs

Agency	Program
Cal Trans, Division of Highways	Picks up litter on State highways as a part of its highway maintenance activities. Action taken only in response to a complaint.
California Highway Patrol	Enforcement of anti-litter laws on highways.
State Solid Waste Management Board	Review litter management and propose control methods and legislation.
East Bay Regional Park District	Maintain park areas and provide litter receptacles.
Alameda County Flood Control District	Collect litter thrown into waterways, both for flood control and aesthetic purposes.
County Sheriff's Office	Enforcement of the County litter ordinance. Notifies the County Road Department when litter and other debris requires removal.
County Road Department, Construction and Maintenance Division	Maintenance of County roads, street sweeping program occurs on a regular basis. Litter pick-up is on an "as needed" basis.
County Health Department	Investigate litter complaints, request clean up by violators.
Cities in Alameda County	Most cities provide regular street sweeping, provide public trash cans, litter pick-up where needed; exceptions and additional services are: Emeryville: no litter pick-up service, responsibility of property owner. Hayward: active public education program.

Source: Alameda County Planning Department and Brown and Caldwell

Legislation Pertaining to Litter

The following legislation is relevant to the management of litter in Alameda County.

Litter Control, Recycling and Resource Recovery Act of 1977 - Senate Bill No. 650. This bill was recently enacted to reduce the proliferation and accumulation of litter in the state. It was the belief of the Legislature that uniform state action rather than independent county, city or regional action was necessary to accomplish effective litter control.

A fund to finance the programs of the bill will be sustained by taxes on all manufacturers, wholesalers and the operation of metropolitan solid waste disposal sites. The State Solid Waste Management Board expects at least $18 million will be available annually. Of this amount, 30 percent will be expended on the clean-up of the state's recreational land and public thoroughfares, 7-1/2 percent for increasing public awareness of the litter problem and for assisting in nonprofit clean-up drives, 5 percent for the improved enforcement of litter-related laws, 2-1/2 percent for the purchase, installation, maintenance and replacement of litter recepticles, and 5 percent for research and administrative support of grant and loan programs, maintenance of solid waste management plans and surveys of litter and solid waste composition. The remaining 50 percent of the funds will be directed towards research and development programs for the recovery of resources and energy from wastes (20 percent), the expansion of existing and the creation of new community recycling centers (25 percent), and the demonstration and evaluation of programs and projects related to delivery to market and utilization of recoverable materials (5 percent).

Senate Bill 650 creates a comprehensive statewide litter control, recycling, and resource recovery plan under the direction of the State Solid Waste Management Board. Funds will not be available until early 1979 and as yet the county program for the expenditure of its proportion of the funds has not been finalized.

Fish and Game Code (5650-5652). Prohibits the dumping of litter or trash within 150 ft of the high water mark.

Health and Safety Code (13002). This bill establishes penalties of $10 to $500 for throwing burning or other waste from cars on to roads and adjacent areas.

Health and Safety Code (14930-14931). Counties are authorized to require owners, occupants and lessees of property to remove dirt, rubbish, weeds and litter from premises.

Penal Code (370-374e). Prohibits littering on public highways.

Street and Highways Code (224, 8882). Littering at roadsite rest stations and parkways is unlawful.

Vehicle Code (1.817, 23111-23113, 23114-23115). Highway and street littering are outlawed and procedures for reporting and preventing littering are described.

Quantity and Composition

There have been no studies of litter volumes in Alameda County. However, it is not expected that present or future volumes will be significant in terms of the total solid waste quantities, and therefore, litter volumes should not influence the planning of solid waste management facilities.

Litter composition is variable from one locality to another although on a regional basis composition can be assumed to be uniform. A statewide study has indicated litter composition to be as shown in Table A-7. On a weight basis the table shows the combustible content to be approximately 66 percent, with paper representing about half of this percentage.

DEMOLITION WASTES

Demolition wastes are inert materials such as concrete, glass and brick, which result from the destruction of obsolete structures, land clearing operations and excavations. These wastes are either hauled and reused as fill at new construction sites or are diposed at a Class II or Class III landfill site. Demolition wastes are a viable cover material and their use at Class II sites is common practice, particularly where cover material is in short supply or Class III sites are inconveniently located.

Demolition Landfill Sites

In the western part of the county, disposal sites are limited both in number and capacity. In the eastern sector, the East County landfill (Vasco Road) has approximately 20 years capacity[13] and the proposed Altamont site more than 50 years capacity.[15]

Table A-8 shows the existing and proposed landfill sites for demolition wastes. The site classification, capacity, daily quantity of waste disposed and the expected life are also shown.

Table A-7. Estimated Litter Composition

Item	Weighted average for state, percent of items
Basic convenience product litter	
Candy, gum, ice cream, nuts, cookies, etc.	17
Pulltops	11
Cigarettes, cigars, matches, tobacco, etc.	10
Cups, lids, and straws	8
Beer cans, bottles, crowns, carriers	7
Napkins, facial and toilet tissue, paper towels	6
Soft drink cans, bottles, crowns, carriers	4
Paper bags, sandwich wrap, picnic plates, coolers	3
Take-out food packaging (hamburger, fries, etc.)	2
Juice, wine and liquor cans, bottles	1
Plastic carriers and other unidentified beverage litter	1
Subtotal	70
Other products and materials	
Forms, tags, instructions, bills stationery supplies	4
Miscellaneous paper, cardboard packaging and wrapping	2
Vehicle parts, supplies, debris, forms	2
Food packaging	2
Plastic bottles, tubs, rubber products	2
Advertising--handouts, coupons, business cards, signs	1
Furniture, construction debris, wood, rope, etc.	1
Newspaper	1
Toiletries	1
Clothing	1
Toys, sporting goods, photo supplies	1
Subtotal	18
Other litter - product source unidentifiable	
Paper--miscellaneous small pieces	4
Plastic--miscellaneous small pieces, tape, bags	4
Metal cans, foil, and other	4
Subtotal	12
Total, all litter	100

Source: Reference 15.

Table A-8. Existing and Potential Landfill Sites Suitable for the Disposal of Demolition Wastes

Site	Class	Estimated daily demolition disposal,[b] TPD	Expected site closure
Davis Street	II	210	1979
Shepherd Canyon Road (Oakland)	III	Unknown	1979
Buchanan Street Extension (Albany)	III	30 - 150	1979-83
San Leandro (foot of Marina Boulevard)	III	100	1981
Berkeley	II	200	1983
Durham Road	II	Unknown	1980
East County (Vasco Road)	II	16	2004
Moraga Road at Pala Avenue	III	100 yd^3/year	Unknown
U.S. Naval Air Station, Alameda	Not applicable	25	Unknown
Turk Island	II	140	Unknown
Altamont	II	Unknown	2030
Kaiser gravel pits	-		Unknown
Lone Star gravel pits	-	3	Unknown
Christie concrete	Not classified as yet	Unknown	Unknown
Quarries in the Redwood Road Area of East Oakland (potential)	a	Not applicable	Unknown
Gravel pits in the Niles District near Fremont (potential)	a	Not applicable	Unknown
Quarries in the Coyote Hills area near Newark (potential)	a	Not applicable	Unknown

[a] A RWQCB permit would be required prior to starting operations at this site.

[b] Disposal rate estimated for 1977.

Demolition Quantities. Present quantities of demolition wastes generated in the county are estimated to average 1000 tons per day. The estimate is based on discussions with site operators, regulatory agencies and city staffs and site observations. The quantity will vary from day to day, season to season, and year to year according to weather conditions, regional policies, the demand for new facilities, and the age of the community.

The uncertainties make precise determinations impractical for the medium-term and incorrect for the long-term planning period. However, some value must be set so that facility planning can be completed for this significant quantity of wastes.

Overall, future quantities of demolition wastes are likely to increase. As the population increases and facilities age there will be a demand for larger and more efficient facilities to replace those that are obsolete. Based on population growth alone and assuming no change in the demolition waste generated per capita, the quantity of demolition material requiring disposal within the county is likely to exceed 1,100 tons per day by 1985 and 1,200 tons per day by 1995.

The closing of sites in the western part of the county will ultimately result in wastes being hauled at considerable expense to the larger capacity sites in the eastern sector. The proposed Altamont landfill site is expected to handle over 2,000 tons per day of Group II waste and based on this daily disposal rate Altamont has a lifetime of 50 years or more.[15] This life cycle will be reduced if demolition wastes exceeding 1000 tons per day are delivered to the site.

Demolition Waste Disposal Site Selection

The approval of the RWQCB is required before a site can be designated as a Class III site and thus considered suitable for demolition waste disposal. Potential Class III landfills were listed in Table A-8. Since existing landfills will be closing in the western part of the county, the Solid Waste management authority should begin to investigate the suitability of these sites for use as Class III landfills.

WATER AND WASTEWATER TREATMENT PLANT SLUDGES

Sludges are the solid waste residue resulting from the treatment of sewage in a wastewater treatment plant or water in a water purification plant.

Water Treatment Plant Sludges

There is only one water treatment plant in continuous operation in Alameda County. This facility (the Upper San Leandro Filter Plant) is operated by the East Bay Municipal Utility District (EBMUD) and is located on Greenly Drive in Oakland. The average plan in the plant is 30 mgd. Solids are collected and are discharged to the sewer. The quantity of solids collected in the plant is not known; however, it would be insignificant in comparison to the quantity of wastewater solids generated over the same period of time and since the solids generated by the water treatment plant ultimately become part of the wastewater solids stream, they are considered to be included in the projected quantity of wastewater sludge generated in Alameda County.

Wastewater Treatment Plant Sludge

Numerous agencies are responsible for the handling and disposal of wastewater sludge. A list of the agencies and their responsibilities is given in Table A-9.

Alameda County is served by eight major wastewater agencies. Table A-10 shows the estimated 1977 production of sludge solids for each agency.[17]

To comply with the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500), the agencies listed in Table A-10 are upgrading the level of wastewater treatment, resulting in the generation of larger volumes of sludge.

The San Francisco Bay Region Wastewater Solids Study estimates that sludge production in Alameda County will reach 93 dry tons per day by 1980 and 105 dry tons per day by 1990.[18] Based on these figures, sludge production in 1985 and 1995 is estimated to be approximately 100 and 110 dry tons per day respectively.

The methods of sludge disposal adopted by each agency are as follows:

- The Dublin-San Ramon Services District and the Cities of Pleasanton and Livermore presently store their sludge in lagoons at the plant sites. Periodically the sludge is removed and spread on the land or given to local farmers for agricultural use.

- EBMUD disposes of its sludge at the West Contra Costa landfill in Richmond.

- The City of San Leandro disposes of its sludge at the Davis Street landfill.

Table A-9. Agencies Responsible for Wastewater Sludge Management in Alameda County

Agency	Responsibility
Environmental Protection Agency	Implementation of the Solid Waste Disposal Act recommended by the Resource Conservation and Recovery Act (RCRA) of 1976. Development of strategy to meet legislative mandates of RCRA and other environmental legislation. Encourage resource conservation and recovery as the preferred solid waste management approach whenever techically and economically feasible.
California Department of Health (DOH)	Controlling health aspects associated with sludge disposal or use. Regulations developed by DOH could have a significant impact on composting, agricultural use, and other beneficial use practices.
State Solid Waste Management Board	Developing a regional solid waste management plan based primarily on the county solid waste management plans.
State Water Resources Control Board	Responsible for water pollution control activities in the state.
Association of Bay Area Governments	Development of a comprehensive Environmental Management Plan for the Bay Region.
San Francisco Bay Region Wastewater Solids Study	Development of a regional plan for wastewater solids management, development of detailed facilities plans for the four largest wastewater treatment agencies. The regional plan will be incorporated into the Solid Waste Plan and integrated with the overall Environmental Management Plan.
Bay Area Air Pollution Control District	Implementation and enforcement of Federal and State air quality standards for stationary combustion facilities.
County Planning Department and County Solid Waste Management Agencies	Local jurisdiction over solid waste management and are a key element to implementation of sludge management project. Coordinate with Wastewater Solids Study.

Source: Reference 18 and Brown and Caldwell

Table A-10. Sludge Solids Production in Alameda County, 1977

Agency	Service area	Sludge solids produced, dry TPD
East Bay Municipal Utility District	Alameda, Albany, Berkeley, Emeryville, Oakland, Piedmont, Stege Sanitary District	45
San Leandro	San Leandro	7.5
Oro Loma and Castro Valley Sanitary District	Castro Valley, Hayward, San Leandro	8
Hayward	Hayward	6[a]
Union Sanitary District	Fremont, Newark, Union City	10
Dublin-San Ramon Services District	Dublin, Part of Pleasanton, San Ramon	1.6
Pleasanton	Part of Pleasanton	0.9
Livermore	Livermore	2
Total		81

[a] 18 dry TPD in cannery season.

- The City of Hayward disposes of its sludge by distributing it locally as a soil conditioner and potting material by a private distributor.

- Oro Loma Sanitary District disposes of its sludge by distributing it to the public as a soil conditioner. A multiple-hearth incinerator is available for combustion of excess quantities of sludge.

- Union Sanitary District is designing a new consolidated treatment plant in Alvarado. The sludge will be landfilled or composted and marketed as a soil conditioner by a local distributor.

Alternative disposal methods are being evaluated by the solids study and by each of the agencies. The use of sludge for agricultural land application and the combustion of sludge with refuse appear to be the most promising methods.

The quantity of sludge estimated for 1985 and 1995 represent, on a dry basis, less than 5 percent of the total waste stream. This is the amount of material which may be required to be landfilled. Since a significant proportion of the sludge will be used or incinerated, the landfilling of the remainder will not be a major consideration in the planning of future solid waste disposal facilities.

INDUSTRIAL WASTES

There are a large number of industries in Alameda County which generate a significant amount of wastes. The wastes are handled and disposed either as a part of the mixed municipal waste handling systems or as a separate industrial waste system. Quantitative data on industrial waste quantities was given in the Alameda County short-term facilities plan. For this medium- and long-term facilities plan, industries have been contacted regarding the handling of their wastes. Such data will be useful in evaluating the size and type of transfer, processing, and disposal facilities needed in the future.

Industrial Waste Quantities

The quantity of industrial wastes has been estimated by the Alameda County Planning Department to be 388,000 tons per year. The background for that quantity is given in the Alameda County short-term facilities plan. Of that amount, approximately 151,000 tons are generated at food processing industries. About 41,000 tons of that food processing waste was hauled out of the

county for reuse or disposal. Of the remaining wastes, about 208,000 tons are generated by the heavy and light manufacturing industries. Previous studies did not estimate the amount of manufacturing wastes that are recycled to salvage and therefore would not be handled in the medium- and long-term waste management facilities. Thus, a review of various industries was undertaken to confirm the amount of industrial wastes generated in Alameda County and to determine the amount of recycling which occurs.

Industrial Questionnaire

An industrial solid waste questionnaire was sent to approximately 35 heavy and light manufacturing industries. Responses were received from 9 of those questioned. This small sample and limited response did not result in hard data to verify or modify the 208,000 tons reported in previous studies. However, three respondents did provide support for the statement that a significant amount of wastes from industry are salvaged and would not be handled by medium- and long-term waste management facilities. The actual quantities are irrelevant, but the percent of total solid wastes sold as salvage by these respondents was 25, 65, and 33.

Conclusions

The limited survey did not provide sufficient data to confirm or modify the previously stated quantity of industrial wastes. Therefore, the medium- and long-term facilities plan will contain provisions for handling and disposing of approximately 1,000 tons per day of industrial wastes (388,000 tons per year generated 41,000 tons per year of load waste shipped out of county = 339,000 tons per year). Until more data is available that quantity is projected to remain constant through 1985 and 1995.

STORAGE, COLLECTION AND DISPOSAL FACILITIES

There are 16 agencies in Alameda County which have responsibility for the handling and disposal of solid waste generated within their jurisidiction. Thirteen of these agencies are cities, two are sanitary districts, and one is a services district the approach and facilities which each of these agencies have employed to satisfy their responsibilities in these areas are discussed below.

Type of Collection and Disposal Services

The most common approach to solving the problems of collecting, hauling and disposing of solid waste in Alameda County has been for the various agencies to franchise with a private collector to

either collect and dispose of the waste where the agency instructs them or franchise with a private collector to collect and dispose of the waste. A summary of who collects waste in each jurisdiction is presented in Table A-11.

As can be seen in Table A-11, Oakland Scavenger Company provides services for 12 of the 16 agencies. There are two municipal collection agencies, one in San Leandro, the other in Berkeley. The Cities of Alameda and Pleasanton franchise with private collectors other than the Oakland Scavenger Company.

Inventory of Storage and Collection Facilities

Each of the agencies or companies which were identified in Table A-11 as having responsibility for collection service were contacted to establish the number, size and type of vehicles which they are presently using in their systems. This information is presented in Table A-12.

Inventory of Disposal Facilities

There are very few solid waste disposal sites in Alameda County which will be operating in 1985. A summary of the landfills which are currently operating and which accept residential commerical and industrial wastes and their expected closure dates are presented in Table A-13. Landfills which accept primarily group 3 materials, that is, demoliton wastes and insert debris, were listed in Table A-8.

REFERENCES

1. State Dept. of Health, Health and Safety Code, Div. 20, Chpt. 6.5.
2. State Dept. of Health, Hazardous Waste Regulations, Title 22, Register 77, No. 42, 10-15-77.
3. Alameda County Planning Department, Hazardous Industrial Waste Survey of Selected Manufacturing Industries in Alameda County, California, June 1977.
4. Administrative Code of the State of California, Title 23, Chpt. 3, Subchapter 15 (adopted March 2, 1972).
5. California Department of Food and Agriculture, Laws and Regulations Study Guide for Agricultural Pest Control Advisor, Agricultural Pest Control Operator, Pesticide Dealer, Agricultural Pilot Examinations, p. 5.

Table A-11. Responsible Agencies and Collection and Disposal Agencies/Companies for Handling Solid Waste in Alameda County

Responsible agency	Collection agency/company	Disposal agency/company
Alameda	Alameda City Disposal Company	City of Alameda
Albany	Oakland Scavenger Company	Oakland Scavenger Company
Berkeley	City of Berkeley	City of Berkeley
Castro Valley Sanitary District	Oakland Scavenger Company	Oakland Scavenger Company
Dublin-San Ramon Services District	Oakland Scavenger Company	Oakland Scavenger Company
Emeryville	Oakland Scavenger Company	Oakland Scavenger Company
Fremont	Oakland Scavenger Company	Oakland Scavenger Company
Hayward	Oakland Scavenger Company	Oakland Scavenger Company
Livermore	Livermore Disposal Service[a]	Livermore Disposal Service
Newark	Oakland Scavenger Company	Oakland Scavenger Company
Oakland	Oakland Scavenger Company	Oakland Scavenger Company
Oro Loma Sanitary District	Oakland Scavenger Company	Oakland Scavenger Company
Piedmont	Oakland Scavenger Company	Oakland Scavenger Company
Pleasanton	Pleasanton Garbage Company	Pleasanton Garbage Company
San Leandro	City of San Leandro	Oakland Scavenger Company
Union City	Oakland Scavenger Company	Oakland Scavenger Company

[a]A division of Oakland Scavenger Company.

Table A-12. Inventory of Storage and Collection Facilities, number of units unless otherwise noted

Item	Oakland Scavenger Company	City of Berkeley	Pleasanton Garbage Company	City of San Leandro	Alameda City Disposal Company
Number of accounts					
Residential and commercial	262,500	25,000	7,500	16,000	20,000[a]
Front end loader	6,300	1,200	100	275	-
Drop box	varies	0	5	50	-
Number of routes					
Rear loader (Mon-Fri/Sat//Sun)	115/6//0	15/4//0	3/0//0[a]	7/0//0	8/0//0[b]
Front loader (Mon-Fri/Sat//Sun)	28/4//0	3/2//0	1/0//0	2/1//0	0
Drop box (Mon-Fri/Sat//Sun)	varies	varies	1/0//0	2/0//0	3/0//0
Number of trucks					
Rear loader	115	15	3	9	9
Capacity, cu yd	17-38	16-20	20	20	25
Front loader	27	3	1	3	0
Capacity, cu yd	38-42	24	20	33-41	N.A.
Drop box	35	1	1	2	3
Side loader	-	-	-	1	6
Capacity, cu yd	-	-	-	10	25
Number of containers					
Front loader	10,000	1,900	200	275	650
Capacity, cu yd	1-7	1-6	2-4	2-3	1-2
Drop box	1,700	12	50	15	75
Capacity, cu yd	12-50	15-20	15	10-20	14
Crew size					
Rear loader	3	3	2	2	3
Front loader	2	3	1	2	N.A.
Drop box	1	N.A.	1	1	1
Side loader	-	-	-	2	3

[a]Includes residential, commercial and drop box.

[b]Includes 2 side loader routes.

Table A-13. Inventory of Solid Waste Disposal Sites in Alameda County

Disposal site	Regional Water Quality Control Board classification	Fill rate, acre-ft/yr	Expected site closure
Alameda	II - 2	30	a
Berkeley	II - 2	117	1982
Davis Street	II - 2	317	1978
Turk Island	II - 2	15	1982
Durham Road	II - 2	140	1979[b]
East County (Vasco Road)	II - 2	100	2004
Altamont	II - 1	Not operating	2030

[a]Site is at capacity: landfilling will continue until an alternative is found.

[b]If an extension is granted site closure will not occur until after 1995.

6. California Administrative Code, Title 3, Sections 2448 and 2461.

7. 1977 County of Alameda Agricultural Crop Report.

8. Alameda County Agricultural Commissioners Office, March 1978.

9. California Administrative Code, Title 3, Chpt. 4, Section 3141, 3142.

10. Atomic Energy Act, 1954 (as amended)

11. California State Health and Safety Code, Division 20, Chpt. 6.5.

12. Code of Federal Regulations, Vol. 49, 100-199 (Dept. of Transportation).

13. State Senate Bill No. 650.

14. Brown and Caldwell, Questionnaire Survey of Alameda Agencies, Jan. 1978.

15. Syrek, D.B., California Litter. A Comprehensive Analysis and Plan for Abatement. Institute for Applied Research - California State Assembly Committee on Resources and Land Use. May 1975.

16. Oakland Scavenger Company, A Long-Range Solid Waste Management Program. June 1975.

17. California State Solid Waste Management Board, Disposal of Environmentally Dangerous Wastes in California, August 1976.

18. San Francisco Bay Region Wastewater Solids Study Draft Wastewater Solids Plan, January 1978.

19. Task Force on Medical Services Waste Disposal, Guidelines for Handling and Disposal of Hazardous Wastes Associated with Medical Services, 1974.

APPENDIX B

POPULATION

APPENDIX B

POPULATION

The population figures used in this report are based on estimates developed by the State Department of Finance for the incorporated areas of the county and estimates given by representatives of the three service districts in the county for the unincorporated areas of the county. Residents living in unincorporated areas, outside of service district boundaries, are not included in these population projections. Population estimates for 1977 are increased in accordance with the "B Series" population increases which are developed and used by the Alameda County Planning Department for planning purposes. The "B Series" estimates are continually updated, so the population estimates for 1985 and 1995 may change.

There are 16 agencies in Alameda County which are responsible for the collection and disposal of solid waste in their service area. For the purposes of this facilities plan, each of these agencies' service areas was taken as a "waste generation area." The population of each waste generation area was established to provide a basis for projecting the population and the quantities of solid waste generated in each waste generation area. This approach allows each of the 16 agencies to address the specifics of the plan as it applies to their jurisdiction. The populations of the incorporated areas and the service districts in Alameda County in 1977 are presented in Table B-1.

Since part of the City of San Leandro is serviced by the Solid Waste Collection Division of the City of San Leandro and part by the Oakland Scavenger Company, the population presented for the City of San Leandro in Table B-1 only includes the population of San Leandro serviced by the Solid Waste Collection Division. The remainder of the population is included in the population figure for the Oro Loma Sanitary District.

The Alameda County Planning Department has divided the county into four planning areas known as:

- The Central Metropolitan Planning Unit (CMPU) - includes the Cities of Albany, Berkeley, Piedmont, Oakland and Emeryville.

- The Eden Planning Unit (EPU) - includes the Cities of Hayward and San Leandro and the Oro Loma and Castro Valley Sanitary Districts.

Table B-1. Population of Solid Waste Generation Areas in Alameda County, 1977

Waste generation area	Population
Alameda	70,600[a]
Albany	14,100
Berkeley	108,900
Castro Valley Sanitary District	38,000[b]
Dublin-San Ramon Services District	19,000[b,c]
Emeryville	4,200
Fremont	117,000
Hayward	96,900
Livermore	48,500
Newark	29,800
Oakland	338,000
Oro Loma Sanitary District	97,200
Piedmont	10,500
Pleasanton	33,700
San Leandro	41,000[d]
Union City	32,900

Source: State Department of Finance, Report 77E-1, May 10, 1977, unless noted.

[a] Population does not include the number of military personnel assigned to ships stationed at the Alameda Naval Air Station.

[b] Personal communication with representative of service district.

[c] Approximately one half of the population resides in San Ramon in Contra Costa County.

[d] Only includes the population of San Leandro served by the San Leandro Solid Waste Collection Division.

- The Washington Planning Unit (WPU) - includes the Cities of Fremont, Newark and Union City.

- The Livermore-Amador Valley Planning Unit (LAVPU) - includes the Cities of Livermore and Pleasanton, and the portion of the Dublin-San Ramon Services District which is in Alameda County, and the eastern portion of Alameda County which is unincorporated.

The Alameda County Planning Department continually updates the population projections for the county on a planning unit basis. In order to determine future populations of the waste generation areas, the following procedure was followed. Each generation area is located in one of the planning units. The projected annual rate of growth over the period under consideration, as developed by the planning department for each planning unit as a whole, was applied to the population of each waste generation area from the 1977 populations given in Table B-1.

The "B Series" Population Projections for each of the planning units are given in Table B-2. In Table B-3, the populations of the waste generation areas in 1977, 1985 and 1995 are given. The planning unit to which each waste generation area belongs is also indicated.

The populations given in Table B-3 are used throughout the report and are used for developing future waste quantities for each generation area.

Table B-2. Population Projections and Average Growth Rate of Alameda County

Year	Planning unit			
	CMPU	EPU	WPU	LAVPU
1975 population, thousands	585	285	181	103
1985 population, thousands	601	303	234	137
1975-1985 ten year average growth rate, percent	2.7	6.3	29.3	33.0
1995 population, thousands	601	320	304	179
1985-1995 ten year average growth rate, percent	0.00	5.6	29.9	30.7

Source: Alameda County Planning Department, "B Series" revised and subject to revision.

Table B-3. Current and Projected Population for Waste Generation Areas

Waste generation area	Planning unit	Population 1977	Population 1985	Population 1995
Alameda	CMPU	70,600	72,100	72,100
Albany	CMPU	14,100	14,400	14,400
Berkeley	CMPU	108,900	111,300	111,300
Castro Valley Sanitary District	EPU	38,000	39,900	42,100
Dublin-San Ramon Service District	LAVPU	19,000	24,600	32,000
Emeryville	CMPU	4,200	4,300	4,300
Fremont	WPU	117,000	144,400	187,600
Hayward	EPU	96,900	101,800	107,500
Livermore	LAVPU	48,400	61,300	80,100
Newark	WPU	29,800	36,800	47,800
Oakland	CMPU	338,000	345,300	345,300
Oro Loma Sanitary District	EPU	97,200	102,200	107,900
Piedmont	CMPU	10,500	10,700	10,700
Pleasanton	LAVPU	33,700	42,600	55,700
San Leandro	EPU	41,000	43,100	45,500
Union City	WPU	32,900	40,600	52,700
Total		1,100,200	1,195,400	1,317,000

APPENDIX C

SOLID WASTE QUANTITIES

APPENDIX C

SOLID WASTE QUANTITIES

This appendix presents the sources and quantities of solid waste generated within Alameda County and forecasts the amount of solid waste which can be expected to be generated in the future. These projections are used throughout the report to evaluate alternatives for handling solid waste and to recommend locations for solid waste management facilities. Other quantitive estimates appear in Appendix A. The data presented in this Appendix is intended to be used for planning for only medium- and long-term facilities. Thus, wastes to be processed for materials recovery and energy conversion are highlighted in Appendix H. This detail is essential in order to properly size these facilities whereas less detailed quantity information, such as appears in Appendix A, is often adequate for sanitary landfill capacity determinations.

Currently available estimates of solid waste quantities were used from existing sources such as permit applications, solid waste studies and the short-term Alameda County Solid Waste Management Plan to develop the waste quantities presented herein.

WASTE SOURCES AND CHARACTERISTICS

There is only a limited amount of field-measured data available on the quantities of waste from each waste generation area. Therefore, the following procedure was developed to apportion the wastes which are collected in Alameda County and disposed to landfills to each of the waste generation areas.

In order to determine the amount of material which could be considered as processable waste for resource recovery facilities, the quantities of various types of waste such as residential, commercial, industrial and demolition debris is required. However, there are no available data on the quantities of each of these streams in all of Alameda County. Therefore, it was assumed that collection vehicles operated by the various collection agencies collect a combined stream of residential, commercial and light industrial wastes. In establishing this category, it has been assumed that large industrial waste generators haul directly to the landfills and that demolition debris is also produced in sufficient quantity that justifies contracted pickup and disposal. Estimates of residential, commercial and light industrial waste quantities are developed in this appendix.

Estimates of the amount of industrial, hazardous, construction and demolition wastes, water and wastewater sludges, and litter are presented in Appendix A.

RESIDENTIAL, COMMERCIAL AND LIGHT INDUSTRIAL

The only landfills in Alameda County presently equipped with scales are the Vasco Road, Durham Road and Davis Street landfills. There have been collection vehicle counts at the Alameda, Davis Street and Berkeley Landfills. Based on the limited weighings, vehicle counts and the landfill volumes which are periodically surveyed, the operators of the landfills have estimated the daily tonnage delivered to the landfills. These estimates have been submitted to the Alameda County Public Health Service as part of the solid waste facilities permits for operation of the landfills. As of March 1978, facility permits had been issued for the Altamont, Davis Street, Durham Road and Alameda N.A.S. Landfills.

The City of Berkeley is conducting a solid waste study and has taken vehicle counts and made projections on the amount of wastes disposed in the Berkeley Landfill from inside and outside of Berkeley. The study also has projected the amount of waste generated inside Berkeley and disposed outside of Berkeley; these wastes are primarily from the University of California. The City of Alameda has conducted vehicle counts and developed projections for the amount of waste received at the Alameda landfill.

Derivation of Per Capita Waste Generation Figures

Six landfills (Davis Street, Durham Road, Berkeley, Alameda, East County, and NAS Alameda) receive virtually all of the residential, commercial and light industrial waste generated in Alameda County. Each of the waste generation areas is subsidiary to primarily one landfill. Thus, based on the population of each waste generation area as given in Appendix B, a per capita waste generation figure was developed for each waste generation area. This per capita figure was assumed to include the residential, commercial and light industrial wastes generated in that area. The number does not include demoliton and construction debris, street sweepings and the like.

There is uncertainty at the federal, state, and local government level on the extent and rate of increase of the pounds per capita per day of wastes generated in communities. In general as a community becomes more urbanized, per capita waste generation does not increase. Urban areas have very small increases in per capita production for residential, commercial and light industrial wastes. Rural areas and developing communities will have a more

rapid future increase in per capita production because of the increase in commercial and light industrial establishments in the community. Since Alameda County is primarily an urbanized area an annual increase in the per capita waste generation figure of 1 percent has been selected for use in this report.

The amount of wastes delivered to each of the landfills in Alameda County which accepts primarily residential, commercial, and light industrial wastes is given in Table C-1. The per capita waste generation rates are also given in Table C-1. For this analysis it was assumed that approximately 15 percent of the waste delivered to the Davis Street site was construction and demolition waste.

There are three institutions in Alameda County which generate sizable quantities of waste material which can be classified as residential, commercial and light industrial waste material and are not included in the waste quantities in Table C-1. These institutions are the University of California at Berkeley, the United States Naval Air Station, Alameda, and the Lawrence-Livermore Radiation Laboratory, Livermore. Waste material from all of these institutions consist primarily of paper, packing materials, construction materials and residential wastes. For the purposes of this report these waste quantities are assumed to increase at an annual rate of 1.5 percent. This rate of increase was used to reflect a relatively slow expansion of these facilities in the future. The waste quantities for these facilities are given in Table C-2.

Derivation of Waste Quantities for Each Waste Generation Area

The amount of residential, commercial and light industrial waste generated in each generation area was determined by multiplying the per capita production figures given in Table B-3 and then adding the institutional waste quantities given in Table C-2. These figures are given in Table C-3.

This derivation is the last step in the waste apportionment procedure. The future waste quantities which must be provided for in a medium- and long-term facilities plan are those listed in Table C-3. These estimates are developed for the sizing and siting of materials recovery and energy conversion facilities. A larger quantity might be used when selecting capacity at a landfill facility.

Table C-1. Per Capita Waste Generation; Residential, Commercial, Light Industrial

Landfill	Daily tonnage[a]	Primary subsidiary areas	Per capita waste generation, lb/capita/day		
			1977	1985	1995
Berkeley	214[b]	Berkeley	3.9	4.3	4.7
Alameda	135[c]	Alameda	3.8	4.1	4.6
Davis Street	1,240[c,d]	Albany Castro Valley S.D. Emeryville Hayward Oakland Oro Loma S.D. Piedmont San Leandro	3.9	4.3	4.7
Durham Road	357[c]	Fremont Newark Union City	4.0	4.3	4.8
East County	165[c]	Pleasanton Dublin-San Ramon S.D. Livermore	3.3	3.6	3.9

[a] Based on 365 days/year.

[b] Source: Staff of City of Berkeley.

[c] Source: Solid Waste Facility Permits.

[d] Includes 27 tons/day currently disposed in Berkeley but generated outside of Berkeley. Does not include approximately 210 tons/day of demolition material.

Table C-2. Institutional Waste Quantities

Institution	Disposal location	Waste quantities[a], tons/day		
		1977	1985	1995
University of California Berkeley	Richmond landfill	50	55	65
United States Naval Air Station	Alameda Naval Air Station landfill	25	30	35
Alameda	Richmond landfill	2.5	3	3.5
Lawrence-Livermore Radiation Laboratory	East County landfill	15	17	20

[a]Based on 365 days/year.

Source: Staffs of Berkeley, Alameda Naval Air Station, and Lawrence-Livermore Radiation Laboratory.

Table C-3. Residential, Commercial, and Light Industrial Waste Quantities in Alameda County

Waste generation area	Waste quantities, tons/day		
	1977	1985	1995
Alameda[a]	165	180	200
Albany	30	30	30
Berkeley[b]	265	290	330
Castro Valley Sanitary District	75	90	100
Dublin-San Ramon Services District	30	40	60
Emeryville	10	10	10
Fremont	230	310	450
Hayward	190	220	250
Livermore[c]	95	130	180
Newark	60	80	110
Oakland	670	740	820
Oro Loma Sanitary District	190	230	250
Piedmont	20	20	30
Pleasanton	55	80	110
San Leandro	80	90	110
Union City	65	90	130
Total	2,230	2,630	3,170

[a] Includes waste generated by U.S. Naval Air Station, Alameda.

[b] Includes waste generated by University of California, Berkeley.

[c] Includes waste generated by Lawrence-Livermore Laboratory.

APPENDIX D

BASIC COST CRITERIA FOR HAULING COLLECTED WASTES

APPENDIX D

BASIC COST CRITERIA FOR HAULING COLLECTED WASTES

Basic cost data presented herein apply to preliminary design or layout of solid waste handling facilities. For this type of general facility planning, it is necessary only that a close approximation of the size, location, type of construction, route and cost of the various facilities be developed and that this information be given in sufficient detail to permit comparisons between alternative plans. The basic cost criteria are presented in three sections identified as direct haul costs for collection trucks, direct haul costs for drop box vehicles, and transfer station and vehicle costs.

DIRECT HAUL COSTS FOR COLLECTION TRUCKS

In this section, the costs for hauling collected refuse from the end of a collection route to a disposal location are developed. The costs for hauling collected refuse are based on the use of a rear-loaded compactor truck with a capacity of 25 yards. Crew size is assumed to vary from one to three men to indicate the increased costs incurred when the collectors accompany the driver to the disposal site. The selected collection vehicle is assumed to contain approximately 7.5 tons of collected waste at the end of its collection route. This unit is larger than most of the collection vehicles in Alameda County, but it provides more efficient operating costs when hauling from the end of the collection route than smaller trucks, so it has been used for comparison purposes herein. The cost estimates are given in Table D-1.

Based on the annual cost given in Table D-1 and assuming the average collection vehicle collects 7.5 tons of refuse on each route and travels 40,000 miles per year in a long-haul situation, a dollar per ton-mile figure was calculated for each of the crew sizes. These costs are:

- 1-man crew - $0.17/ton-mile
- 2-man crew - 0.26/ton-mile
- 3-man crew - 0.34/ton-mile

Table D-1. Haul Cost for Collection Truck

Item	Cost, dollars
Collection truck[a]	60,000
Annual crew wage, per man	25,000[e]
Annual cost of truck[b]	13,000
Annual maintenance cost[c]	9,000
Annual fuel cost[d]	5,000
Total annual cost	
One-man crew	52,000
Two-man crew	77,000
Three-man crew	102,000

[a]Capacity of truck 25 $yards^3$.

[b]Based on CRF - .2163 (A/P, 8 percent, 6 years).

[c]Based on 15 percent of purchase price of vehicle.

[d]Based on $0.50/gallon, 4 mpg, 40,000 miles/year.

[e]Includes fringe benefits.

DIRECT HAUL COSTS FOR DROP BOX VEHICLES

Drop boxes are used by large commercial establishments and industries who generate large volumes of waste. Drop box vehicles, or as they are sometimes known, tilt frame vehicles, carry containers with capacities from 10 to 50 cu yd to these customers, drop off containers and collect full containers. The annual costs for this system are presented in Table D-2. Drop box vehicles are operated by one man. Average tonnage per pickup generally runs about 4 tons per load. Based on 4 tons per load and on annual travel distance of 70,000 miles, drop box vehicles have an average haul cost of $0.19/ton-mile.

TRANSFER STATION AND VEHICLE COSTS

In order to compare the cost of long-haul direct disposal of solid waste by collection vehicles with the cost of other alternatives, the cost of constructing transfer stations and operating transfer vehicles was developed.

Transfer Stations

Costs for the construction of transfer stations with daily capacities of 100, 300, 1,000 and 2,000 tons were estimated based on preliminary layouts of these facilities. Basic design criteria of the transfer stations were:

- Provisions for a scale and scale house.
- Provisions for a public unloading area.
- Collection vehicle unloading area enclosed by a simple metal building.
- Depressed transfer truck loading tunnel.
- Depressed unloading pit for the 1,000 tons per day and 2,000 tons per day transfer station.
- Office facilities for administration of transfer facility.
- Vehicle maintenance building for the 1,000 tons per day and 2,000 tons per day transfer stations.

The construction cost estimates do not include costs for land or site-specific costs, such as foundation considerations, property taxes, licenses and regulatory fees. The cost for the transfer

Table D-2. Haul Cost for Drop Box Vehicles

Item	Cost, dollars
Capital cost	
Tilt frame truck[a]	55,000
Drop box containers[b]	24,000
Annual costs	
Tilt frame truck[c]	11,900
Drop box containers[d]	2,400
Maintenance[e]	5,500
Fuel cost[f]	7,000
Crew wage[g]	25,000
Total annual cost	51,800

[a]25 ton capacity.

[b]Six containers each with 40 cu yd capacity at $4,000 each.

[c]Based on CRF (A/P, 8 percent, 6 years) = .2163.

[d]Based on CRF (A/P, 8 percent, 20 years) = .1019.

[e]Based on 10 percent of purchase price.

[f]Based on 5 mpg, 70,000 miles/year, $0.50/gal.

[g]Based on $25,000/year/man.

stations include the necessary mechanical equipment for the efficient operation of the facility such as bulldozers and backhoes but do not include the cost of transfer vehicles. The costs for the transfer station include the site development costs for access roads, landscaping and fencing the site. The annual costs for the transfer station configuration are given in Table D-3.

Transfer Vehicles

Two types of transfer systems were analyzed to determine what the haul costs are for transporting wastes in transfer vehicles. One system uses self-unloading trailers. These trailers, known as live bottom trailers, have up to four parallel conveyors on the floor of the trailer which unload the wastes at the landfill. The second system uses end dumping trailers which are unloaded by a hydraulic tipper unit located at the landfill. The live floor units can be used with any size transfer station, while the end dumping units are used only with high capacity transfer stations (2,000 tons per day or more). The costs of the alternate trailer systems are given in Table D-4. Since the capacity of the live bottom trailers is approximately 22 tons, the costs in Table D-3 for the live bottom trailers, tractors and drivers are increased by 14 percent to reflect the larger fleet required when using these units. In addition, the capital costs are increased by 10 percent for the live bottom trailers to reflect the necessity of having backup units in case some of the trailers are having the unloading mechanism serviced. Similarly, two tipper units are required at the landfill in case one unit is out of service.

A value was developed for the cost of hauling refuse per ton-mile for each of the transfer systems. This value was based on the cost of hauling 22 tons for 91,000 miles for the live bottom system and 25 tons for 80,000 miles for the end dump system. The numbers are:

- Live bottom system - $0.037/ton-mile

- End dump system - $0.031/ton-mile

The additional costs for the tipper units which are needed for the end dump transfer system are summarized in Table D-5. Since the live floor systems provide for greater flexibility and are appropriate for small installation, the haul costs of the live bottom systems have been used in the transfer station analysis presented in Appendix E.

Table D-3. Annual Cost of Transfer Station

Parameter	Transfer station			
	100 tons/day	300 tons/day	1,000 tons/day	2,000 tons/day
Constructed cost, million dollars	0.88	1.02	2.35	3.85
Annual capital cost[a], thousand dollars	90	103	240	372
Annual capital cost, dollars/ton[b]	2.46	0.95	0.66	0.54
Annual maintenance cost, based on 2 percent of capital cost, dollars/ton	0.48	0.18	0.13	0.10
Operation staff, men	6	6	9	12
Annual operation cost, dollars[c]	150,000	150,000	225,000	300,000
Operation cost, dollars/ton	4.11	1.37	0.62	0.41
Total annual cost, dollars/ton	7.05	2.50	1.41	1.05

[a]Based on CRF, (A/P, 8 percent, 20 years) = .1019.

[b]Based on 365 days a year operation.

[c]Based on $25,000/year/man.

Table D-4. Transfer Vehicle Costs

Item	Live bottom system	End dump system
Capital costs		
Trailer	38,500[a]	24,000
Tractor	53,100[b]	46,600
Annual costs		
Trailer	6,700[c]	3,600[d]
Tractor[e]	13,300	11,700
Annual maintenance costs		
Trailers	3,900[f]	1,200[g]
Tractor[f]	5,300	4,700
Annual operation costs		
Driver costs	36,500[h]	32,500[i]
Truck fuel costs	9,100[j]	8,000[k]
Total annual costs	74,800	61,700

[a]Equals 1.24 times the cost of one live bottom trailer (22 ton capacity).

[b]Equals 1.14 times the cost of one tractor.

[c]CRF, (A/P, 8 percent, 8 years) = .1740.

[d]CRF, (A/P, 8 percent, 10 years) = .1490.

[e]CRF, (A/P, 8 percent, 5 years) = .2505

[f]10 percent of purchase price.

[g]5 percent of purchase price.

[h]Based on average haul speed of 30 mph, 2,080 hrs/year, 91,000 miles/year and $25,000/year/driver.

[i]Based on average haul speed of 30 mph, 2,080 hrs/year, 80,000 miles/year and $25,000/year/driver.

[j]Assuming $0.50/gallon, 5 mpg, 91,000 miles/year.

[k]Assuming $0.50/gallon, 5 mpg, 80,000 miles/year.

Table D-5. Annual Cost of Tipper Units for End Dump Transfer System, dollars unless otherwise noted

	Transfer station			
	100 tons/day	300 tons/day	1,000 tons/day	2,000 tons/day
Purchased cost of 2 hydraulic Tipper units, not self-propelled	300,000	300,000	300,000	300,000
Annual costs of Tipper units				
Annual capital costs[a]	44,700	44,700	44,700	44,700
Maintenance cost[b]	15,000	15,000	15,000	15,000
Fuel costs[c]	1,800	1,800	1,800	1,800
Total annual cost	61,500	61,500	61,500	61,500
Unit cost, dollars/ton	1.70	0.56	0.17	0.08

[a]CRF, (A/P, 8 percent, 10 years) = .1490.

[b]5 percent of purchase price.

[c]10 gallons/day at $0.50/gallon, 365 days/year.

APPENDIX E

TRANSFER STATION ANALYSIS

APPENDIX E

TRANSFER STATION ANALYSIS

Several of the alternative systems for solid waste facilities in Alameda County include transfer stations for handling and transporting the wastes. One alternative system uses transfer stations and haul by transfer vehicles to deliver wastes to landfills in Eastern Alameda County. The economic analysis used for selecting the appropriate number of transfer stations is presented in this section.

COST COMPARISON OF COLLECTION VEHICLES AND TRANSFER FACILITIES

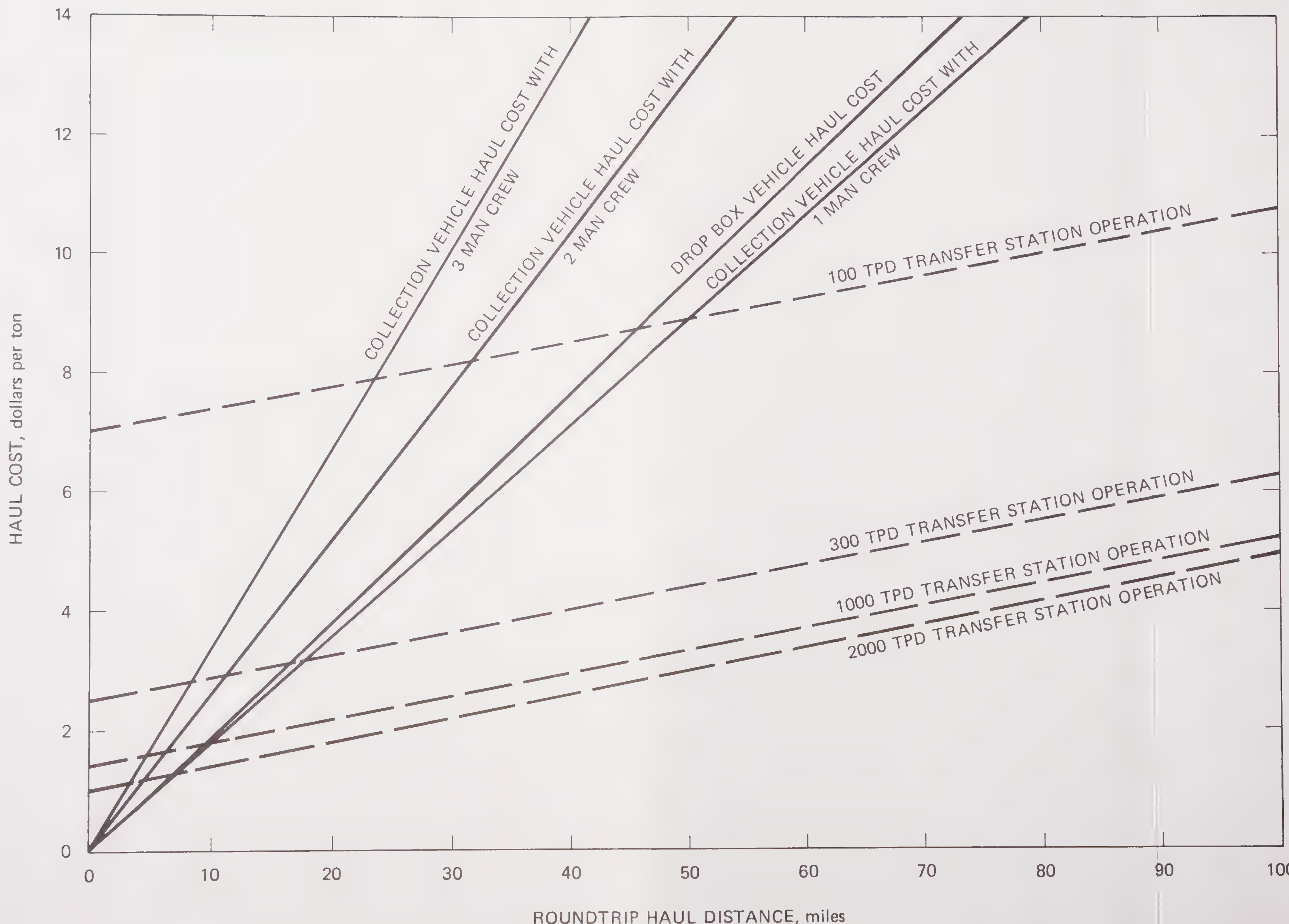
In Appendix D basic cost data were developed for the cost of hauling refuse in collection vehicles and the cost of operating a transfer station and using live bottom transfer vehicles to haul the wastes. These data are combined in Figure E-1 and demonstrate graphically the break-even cost for haul by collection vehicle versus the cost for construction and operation of transfer stations.

By combining the waste quantities for each waste generation area, presented in Table C-3, with the break-even round trip travel distance, as indicated on Figure E-1, it is possible to determine the maximum radius for cost-effective direct haul of waste from each waste generation area. The radius is a travel distance expressed as miles. The one-way break-even travel distances from each waste generation area are given in Tables E-1 and E-2 for 1985 and 1995. The Oakland area was divided into two waste generation areas because of the large quantity of wastes generated in that area. Each of these areas generate approximately the same quantity of waste generated by Fremont and Berkeley. The quantity of waste produced in each area is considered accurate enough to justify the economic analyses related to transportation and handling costs.

Based on the waste quantities for 1995, the break-even radii for the waste generation areas with the larger quantities of solid wastes are shown on Figure E-2. The transfer station analysis assumes that the Pleasanton Transfer Station will continue to be used.

Table E-1. One-Way Break-Even Haul Distances for Collection Trucks to Deliver to Transfer Stations, 1985

Waste generation area	Centroid	1985 Waste quantities, tons/day	Radius of one-way travel, miles		
			3-man crew	2-man crew	1-man crew
Alameda	Santa Clara and Chestnut	180	7	9.5	15.5
Albany	Solano and Talbot	30	>30	>30	>30
Berkeley	City Hall	290	4	5.5	9
Castro Valley Sanitary District	Somerset and Redwood Rd.	90	16	22	>30
Dublin-San Ramon Services District	Highway 680 and County Line	40	>30	>30	>30
Emeryville	Powell and Landregar	10	>30	>30	>30
Fremont	Paseo Padre and Mowry	310	4	5.5	9
Hayward	Harder Rd. and Railroad	220	5.5	7.5	12
Livermore	1st. St. and L. St.	130	11	15	23
Newark	Newark Blvd. and Lafayette	80	17.5	23.5	>30
North Oakland	Grand Ave. and MacArthur	370	4	5	8.5
South Oakland	Seminary and Foothill	370	4	5	8.5
Oro Loma Sanitary District	Lewelling and Hesperian	230	5.5	7	12
Piedmont	Highland and Sierra	20	>30	>30	>30
Pleasanton	Valley and Crestline	80	20	27.5	>30
San Leandro	Marina and Alvarado	90	14.5	19.5	>30
Union City	Dowe and Alvarado-Niles	90	14.5	19.5	>30



BROWN AND CALDWELL
CONSULTING ENGINEERS
WALNUT CREEK, CALIFORNIA

Fig. E-1 Cost of Hauling Collected Wastes and Operating Transfer Stations

Table E-2. One-Way Break-Even Haul Distances for Collection Trucks to Deliver to Transfer Stations, 1995

Agency/city	Centroid	1995 Waste quantities, tons/day	Radius of one-way travel, miles		
			3-man crew	2-man crew	1-man crew
Alameda	Santa Clara and Chestnut	200	6	8	13
Albany	Solano and Talbot	30	>30	>30	>30
Berkeley	City Hall	330	3.5	5	8.5
Castro Valley Sanitary District	Somerset and Redwood Rd.	100	12	16	25
Dublin-San Ramon Services District	Highway 680 and County Line	60	23	>30	>30
Emeryville	Powell and Landregar	10	>30	>30	>30
Fremont	Paseo Padre and Mowry	450	3.5	4.5	7.5
Hayward	Harder Rd. and Railroad tracks	250	5	7	11
Livermore	1st. and L. St.	180	8	11	17
Newark	Newark Blvd. and Lafayette	110	11	15	23
North Oakland	Grand Ave. and MacArthur	410	4	5	8
South Oakland	Seminary and Foothill	410	4	5	8
Oro Loma Sanitary District	Lewelling and Hesperian	250	5	7	11
Piedmont	Highland and Sierra	30	>30	>30	>30
Pleasanton	Valley and Crestline	110	12	16	25
San Leandro	Marina and Alvarado	110	12	16	25
Union City	Dowe and Alvardo-Niles	130	10	14	22

An inspection of Figure E-2 shows that a transfer station could effectively serve the areas of Berkeley, North Oakland and South Oakland if it was located in the Lake Merritt-Piedmont area. Another arrangement would be to locate a transfer station in the North Oakland-Berkeley area to serve North Oakland and Berkeley and a second transfer station in the South Oakland-San Leandro area to serve South Oakland and Oro Loma. However it would not be cost-effective to site three transfer stations in the Berkeley-North Oakland-South Oakland area as this would violate the break-even analysis since collection vehicles can economically haul wastes within that area.

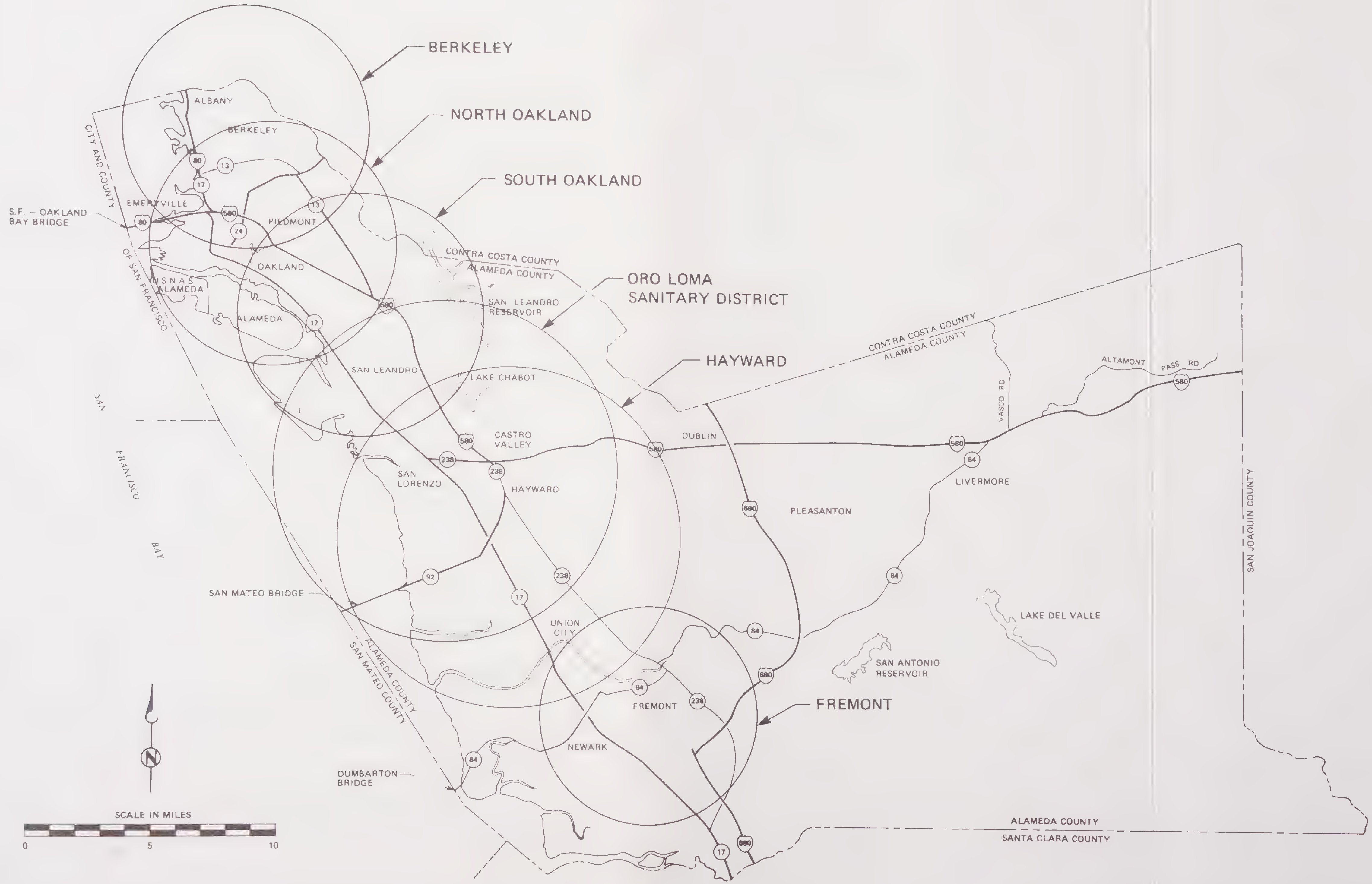
DEVELOPMENT OF COST-EFFECTIVE TRANSFER FACILITIES

In order to determine the preferred, most cost-effective, arrangement of transfer stations, a determination of the costs of using either two or three transfer stations for the Hayward-to-Berkeley area were evaluated. The procedure used is known as the Vogel Approximation Method. It is a hand calculation technique that is considered accurate to within 10 percent of optimum minimal costs. The results indicate the most cost-effective distribution of wastes from the waste generation areas to the various transfer stations. Social and political boundaries are ignored in this evaluation.

Three alternative transfer station systems were developed. The first system envisioned three transfer stations in the Hayward-Berkeley area, one transfer station in the Fremont area and one transfer station in the Pleasanton area. The second transfer station system utilized two transfer stations in the Hayward-Berkeley area, one station in the Fremont area and one transfer station in the Pleasanton area. The third system considered the location of transfer stations at the Berkeley landfill, the Davis Street landfill, in the Fremont area and in the Pleasant area. These alternative arrangements are all discussed in more detail below.

Five Transfer Station System

Based on Figure E-2 and the location of areas which are generally suitable for constructing and operating transfer stations (i.e., primarily industrial areas, easy freeway access, etc.), five general sites were selected. The locations and the capacities of each transfer station are given in Table E-3. The daily haul cost of this system is given in Table E-4.



BROWN AND CALDWELL
CONSULTING ENGINEERS
WALNUT CREEK, CALIFORNIA

Fig. E-2 Break-even Travel Distance With Collection Vehicles for the Larger Waste Generation Areas (2-Man Crew, 1995)

Table E-3. Capacity and Location of Transfer Stations in Alameda County (Five-Transfer Station System)

Transfer station	Capacity, tons/day	General location
T_1	810	Intersection of Highways 17 and 80, Oakland
T_2	610	Oakland-Alameda County Coliseum, Oakland
T_3	840	Hayward Airport, Hayward
T_4	170	Eastern end of Mohr Road, Pleasanton
T_5	560	Durham Road landfill, Fremont

Table E-4. Total Daily Haul Cost for Waste Disposal, Five-Transfer Station System, dollars unless noted

Waste generation area	Transfer station[a]	Haul cost to transfer station	Haul cost from transfer station to landfill	Total daily haul cost
Alameda	T_2	360	890	1,250
Albany	T_1	100	160	260
Berkeley	T_1	590	1,530	2,120
Castro Valley Sanitary District	T_3	240	390	630
Dublin-San Ramon Services District	T_4	240	370	610
Emeryville	T_1	10	50	60
Fremont	T_5	1,430	1,870	3,300
Hayward	T_3	330	990	1,320
Livermore	N.A.	300[b]	N.A.	300
Newark	T_5	440	480	920
North Oakland	T_1	730	1,920	2,650
South Oakland	T_2	450	1,800	2,250
Oro Loma Sanitary District	T_3	280	990	1,270
Piedmont	T_1	50	120	170
Pleasanton	T_4	130	590	720
San Leandro	T_3	280	420	700
Union City	T_3	430	490	920
Total		6,390	13,060	19,450

[a] Transfer station indicated in Table E-3.

[b] Cost of hauling to East County landfill.

Four Transfer Station System

Based on Figure E-2 and keeping transfer station sites generally located in industrial areas and close to freeways, four general sites were selected. The location of the transfer stations and the capacity of each station are given in Table E-5. The daily haul cost of this alternative is given in Table E-6.

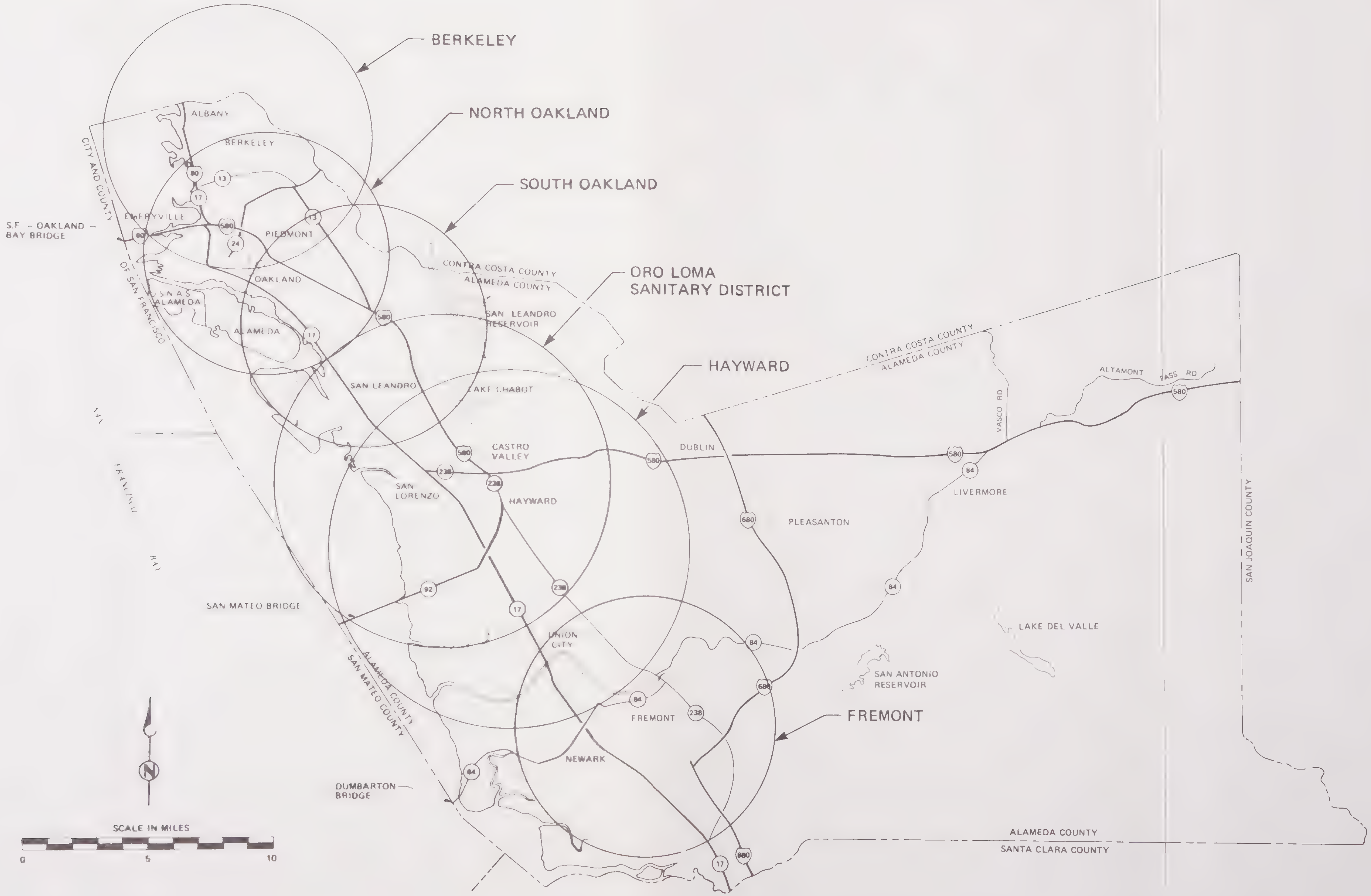
Four Transfer Station System Including Sites Located at the Davis Street and Berkeley Landfills

Since solid waste facilities are being planned for both the Berkeley and Davis Street landfill sites, a four transfer station alternative utilizing these two sites for two of the transfer stations was investigated. The location and capacity of the transfer stations, after using the Vogel Approximation Method to determine the most cost-effective allocation of wastes to each transfer station, are given in Table E-7. The daily haul costs for this alternative are given in Table E-8.

This analysis indicates that a five transfer station alternative results in the least cost for Alameda County in 1995. The transfer stations should generally be located in the North Oakland area, the South Oakland-San Leandro area, the Hayward area, the Fremont area and near Pleasanton. Depending upon the exact location of the transfer station, the tributary waste generation areas for each transfer station may vary from the results obtained using the Vogel Approximation Method.

Transfer Stations, 1985

The break-even travel distances for collection crews hauling refuse in 1985 are presented on Figure E-3. It is assumed that the Davis Street, Durham Road and Turk Island landfills will be closed by 1985. The breakeven distances shown on Figure E-3 indicate that transfer stations will be cost-effective by 1985 and should be built if no landfill sites are available in the western part of the county by 1985.



BROWN AND CALDWELL
CONSULTING ENGINEERS
WALNUT CREEK, CALIFORNIA

Fig. E-3 Break-even Travel Distance With Collection Vehicles for the Larger Waste Generation Areas (2-Man Crew, 1985)

Table E-5. Capacity and Location of Transfer Stations in Alameda County (Four-Transfer Station System)

Transfer station	Capacity, tons/day	General location
T_1	1,010	Fifth Avenue and Highway 17, Oakland
T_2	1,250	Hayward Airport, Hayward
T_3	560	Durham Road landfill, Fremont
T_4	170	East end of Mohr Road, Pleasanton

Table E-6. Total Daily Haul Cost for Waste Disposal, Four-Transfer Station System, dollars unless noted

Waste generation area	Transfer station[a]	Haul cost to transfer station	Haul cost from transfer station to landfill	Total daily haul cost
Alameda	T_1	260	850	1,110
Albany	T_1	130	140	270
Berkeley	T_1	1,110	1,370	2,480
Castro Valley Sanitary District	T_2	240	360	600
Dublin-San Ramon Services District	T_4	240	370	610
Emeryville	T_1	20	40	60
Fremont	T_3	1,430	1,870	3,300
Hayward	T_2	380	910	1,290
Livermore	N.A.	300[b]	N.A.	300
Newark	T_3	440	480	920
North Oakland	T_1	1,060	1,710	2,770
South Oakland	T_2	2,040	1,470	3,510
Oro Loma Sanitary District	T_2	330	910	1,240
Piedmont	T_1	40	110	150
Pleasanton	T_4	130	590	720
San Leandro	T_2	260	390	650
Union City	T_2	430	450	880
Total		8,840	12,020	20,860

[a] Transfer station indicated in Table E-5.
[b] Total cost of haul to East County landfill.

Table E-7. Capacity and Location of Transfer Stations in Alameda County (Four-Transfer Station System Including Davis Street and Berkeley Landfill Sites)

Transfer station	Capacity, tons/day	General location
T_1	810	Berkeley landfill
T_2	1,320	Davis Street landfill
T_3	690	Durham Road landfill
T_4	170	Eastern end of Mohr Road

Table E-8. Total Daily Haul Cost for Waste Disposal Four-Transfer Station System Utilizing Berkeley and Davis Street Landfills, dollars unless noted

Waste generation area	Transfer station[a]	Haul cost to transfer station	Haul cost from transfer station to landfill	Total daily haul cost
Alameda	T_2	530	730	1,260
Albany	T_1	40	170	210
Berkeley	T_1	420	1,600	2,020
Castro Valley Sanitary District	T_2	320	360	680
Dublin-San Ramon Services District	T_4	240	370	610
Emeryville	T_1	10	50	60
Fremont	T_3	1,430	1,870	3,300
Hayward	T_2	990	910	1,900
Livermore	N.A.	300[b]	N.A.	300
Newark	T_3	440	480	920
North Oakland	T_1	1,180	2,000	3,180
South Oakland	T_2	980	1,470	2,450
Oro Loma Sanitary District	T_2	480	910	1,390
Piedmont	T_1	70	120	190
Pleasanton	T_4	130	590	720
San Leandro	T_2	120	390	510
Union City	T_3	660	530	1,190
Total		8,340	12,550	20,890

[a] Transfer station indicated in Table E-7.

[b] Total cost of haul to East County landfill.

APPENDIX F

COMPOSITION OF PROCESSABLE SOLID WASTE

APPENDIX F

COMPOSITION OF PROCESSABLE SOLID WASTE

The composition of the solid waste stream must be determined so that the quantities of recoverable materials can be estimated. The total waste stream consists of residential, commercial, industrial, construction/demolition, agricultural, hazardous wastes, and litter. Hazardous, agricultural, construction/demolition, and litter are not considered processable. Hazardous wastes and other special wastes must be disposed in accordance with specific regulations. Agricultural wastes are generally confined to southern and eastern Alameda County and are generally disposed close to their point of origin and not transported to the major landfills. Construction/demolition debris is generally hauled directly to the landfill and used for cover material. The total quantity of litter is small in comparison to the total waste stream, therefore, it is not considered to seriously impact the processable waste stream. The residential, commercial, and light industrial wastes are considered to comprise the processable waste stream.

Components of the other waste streams can be recovered and reused; however, they would probably not be delivered to a resource recovery facility and mixed with the residential, commercial and industrial wastes prior to their recovery. Construction and demolition debris, for example, could be reused in the manufacture of road building materials. The processable waste stream is comprised of the material which is an appropriate feed stock for resource recovery facilities.

There are no current data available on the composition of processable wastes in Alameda County. Therefore, it was necessary to develop data from the literature on the components in the processable waste stream. After a review of the available data, it was determined that the composition for the residential waste stream and the composition for the commercial and industrial waste stream should be averaged to arrive at the composition of the total processable waste stream.

RESIDENTIAL SOLID WASTE

Residential waste includes residential refuse and rubbish, which are received in the landfills from collection vehicles, and direct customer haul. The quantities of residential waste are directly related to the population in a given area.

In order to provide the users of this plan with as much composition information as possible, eight different composition studies, all relevant to Alameda County, are presented on Table F-1. They are: a study by the State Solid Waste Management Board; one study typical of a municipal waste source in the United States, as determined by the National Center for Resource Recovery; two studies in each of Alameda County, Contra Costa County, and the City of Berkeley. The range of the numbers in Table F-1 indicate that some of the studies may not be appropriate for use in the Alameda County mid- and long-term facilities plan, or that some of the studies did not use the same criteria in evaluating the composition of the waste streams, or that the waste streams were from widely varying sources.

An examination of Table F-1 shows that the combustible fraction varies from 72 percent to 81 percent and that the noncombustible fraction varies from 19 percent to 28 percent. A 10 percent variation should not greatly affect the results of this study but care must be taken not to allow this data to obscure the choices of potential processing alternatives. As specific plans proceed, it is important to adequately sample the waste stream in a given area and determine its composition accurately.

When comparing the Bay Area Solid Waste Composition study with the other individual studies, the following points can be noted. Newsprint at 9 percent agrees with the other studies. The content of corrugated at 5 percent is lower than the national average, but is comparable with results in the Contra Costa County and Berkeley studies. Mixed paper is 10 percent higher than the national average. The plastic component is comparable to the national average and Contra Costa County. The other fractions of combustible material are comparable with the national average and Contra Costa County. The ferrous content is 1 percent lower than the national average, which could be a result of recycling efforts in the Bay Area. The glass rich stream is 1 percent lower than the national average perhaps due to recycling efforts and the location of glass producers in the county.

The composition given for the Bay Area appears to represent an average of the results in Table F-1 and is selected for use in this study for residential waste.

COMMERCIAL AND INDUSTRIAL WASTE

Commercial wastes are from markets, restaurants, stores and office buildings and are generally all processable. Industrial wastes come from industries such as lumber, manufacturing, food processing and petroleum.

Table F-1. Composition of Municipal Solid Waste

Component	Bay area[a] 1977	Alameda County[b] 1975	Alameda County[c] 1976	Contra Costa County[d] 1974	United States Municipal[e] 1973	Contra Costa County[f] 1975	Berkeley[g] 1974	Berkeley[h] 1976
Paper								
Newsprint	9.0	-	9.0	-	8.6	9.0	8.4	11.0
Corrugated	5.0	-	22.0	-	11.6	6.0	6.7	7.0
Mixed paper	32.0	-	12.0	-	22.8	35.0	12.3	12.0
Subtotal, paper	46.0	38.0	43.0	43.0	43.0	50.0	27.4	30.0
Plastics	2.0	4.7	-	-	2.0	2.0	6.3	3.0
Rubber, leather, textiles, wood, etc.	4.0	2.5	5.0[i]	5.0[i]	3.0	4.0	2.1	2.0
Food Waste,	-	-	-	11.5	26.0	5.0	29.6	26.0
Yard trimmings	24.0[j]	33.0[j]	33.0[j]	13.5	-	15.0	6.3	14.0
Total combustibles	76.0	78.2	81.0	73.0	79.0	76.0	71.7	75.0
Metals								
Ferrous	7.0	7.5	8.0	8.0	8.0	7.0	8.5	8.0
Aluminum	0.7	1.3	0.7	0.8	0.7	0.9	1.5	0.8
Other nonferrous	0.3		0.3	0.5	0.3	0.1	-	0.3
Subtotal, metals	8.0	8.8	9.0	9.3	9.0	8.0	10.0	9.0
Glass and ceramics	9.0	12.0	10.0	10.0	10.0	10.0	17.1	11.0
Rocks, dirt and miscellaneous	7.0	1.0	-	7.7	7.0	6.0	1.2	5.0
Total noncombustibles	24.0	21.8	19.0	27.0	26.0	24.0	28.3	25.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] Bay Area Solid Waste Management Program, Phase I, State S.W. Management Board, February 1977.

[b] Long Range S.W. Management Program, Oakland Scavenger Co., June 1975.

[c] Alameda County Solid Waste Management Plan, May 1976.

[d] Solid Waste Resource Recovery Study, Brown and Caldwell, August 1974.

[e] National Center For Resource Recovery, NCRR Bulletin, Spring 1973.

[f] Contra Costa County, Metcalf and Eddy, December 1975.

[g] Berkeley and The Bay-Delta Demonstration Project ... An Environmental Impact Report, University of California, March 1974.

[h] Solid Waste Management System For The City of Berkeley, Solid Waste Management Commission, May 1976.

[i] Includes plastics.

[j] Includes food wastes.

In Alameda County, most of the industrial solid waste is produced by four major industries: (1) primary metal working or smelting, (2) stone, clay, glass, and concrete products, (3) machinery manufacturing, and (4) transportation equipment manufacturing.

Reliable information on the Alameda County commercial and industrial waste stream is scarce. Table F-2 presents the results of six studies which have been conducted on these waste streams.

The Bay Area and Contra Costa County studies are generally in agreement with only slight differences in some of the components. The most recent Berkeley study generally agrees with the Bay Area and Contra Costa studies. The recycleable items such as newsprint, ferrous, and glass are lower than the Bay Area and Contra Costa Studies possibly due to the heavy emphasis being placed on recycling in Berkeley. The Richmond, Oakland and 1967 Berkeley studies are incomplete and the breakdown suggests that complete sampling and analysis was not done.

The Bay Area study is used in this plan as representative of the composition of the commercial and industrial waste stream.

RESIDENTIAL, COMMERCIAL AND INDUSTRIAL WASTE

Because of the difficulty in obtaining accurate waste quantity projections of the residential, commercial and industrial waste streams individually, the streams were combined into a common processable waste stream. A review of various reports of waste composition indicated that the residential portion is approximately 50 percent of the total waste stream. A summary of these reports is given below:

- Oakland Scavengers. This report[1] indicates that of the municipal and industrial waste stream in Alameda County 78 percent is municipal and 22 percent is industrial.

- Portland, Oregon. A recent study[2] reported that the waste stream consisted of 53 percent municipal waste and 47 percent commercial/industrial waste after removing the nonprocessable industrial waste.

- Bay Area. This project report[3] presents a summary of mixed municipal refuse of which 53 percent is residential and 47 percent is commercial/industrial.

Table F-2. Composition of Industrial and Commercial Solid Waste

Component	Bay Area[a] 1977	Contra Costa County[b] 1975	Berkeley[c] commercial 1967	Richmond[d] commercial 1974	Oakland[e] commercial/industrial 1974	Berkeley[f] commercial/industrial 1976
Paper						
Newsprint	5.0	5.0	-	5.0	-	2.0
Corrugated	35.0	35.0	-	15.0	-	33.0
Mixed paper	25.0	25.0	-	47.0	-	25.0
Subtotal, paper	65.0	65.0	68.3	67.0	60.0	60.0
Plastics	3.0	3.0	1.2	8.0	3.0	3.0
Rubber, leather, textiles, wood, etc.	8.0	8	0.3	-	10.0	10.0
Food waste	-	5.0	15.4	-	-	3.0
Yard trimmings	5.0[g]	-	-	-	-	-
Total combustibles	81.0	81.0	85.2	75.0	73.0	76.0
Metals						
Ferrous	4.5	4.0	3.3	-	-	3.0
Aluminum	0.3	0.8	0.4	-	-	0.3
Other nonferrous	0.2	0.2	-	-	-	0.7
Subtotal, metals	5.0	5.0	3.7	9.0	4.0	4.0
Glass and ceramics	8.0	8.0	5.7	9.0	5.0	5.0
Rocks, dirt and miscellaneous	6.0	6.0	5.5	7.0	18.0	15.0
Total noncombustibles	19.0	19.0	14.9	25.0	27.0	24.0
Total	100.0	100.0	100.1	100.0	100.0	100.0

[a] Bay Area Solid Waste Management Project, State S.W. Management Bond, February 1977.

[b] Contra Costa County S.W. Management Report, Metcalf and Eddy, December 1975.

[c] Comprehensive Studies in Solid Waste Management, First Annual Report, University of California. Sanitary Engineering Research Laboratory. SERC Report No. 67-7. Refuse was collected from 72 stores and 28 apartment houses.

[d] Size Reduction in S.W. Processing. Progress Report 1973-1974, College of Engineering, University of California, Berkeley.

[e] Berkeley and the Bay-Delta Demonstration Project ....An Environmental Impact Report, prepared by students in Conservation of Natural Resources Field Major, University of California, Berkeley, March 1974. Data based on observations of vehicles entering the Berkeley landfill.

[f] Solid Waste Management System for the City of Berkeley, Solid Waste Management Commission, May 1976.

[g] Food waste and yard trimmings combined.

- Solid Wastes. This textbook[4] presents data on solid waste in California. Calculations based on these numbers give 62 percent municipal waste and 38 percent industrial waste.

Based on the results of these studies, it was assumed that the Alameda County processable waste stream consists of 50 percent residential waste and 50 percent commercial and industrial waste. The estimated composition of the combined residential, commercial and industrial waste in Table F-3 is thus an average of the composition figures given for the municipal and the commercial/industrial waste streams.

REFERENCES

1. Oakland Scavenger Co., A Long Range Solid Waste Management Program, June 1975.

2. Cor-Met, Pre-Final Submittal Metropolitan Service District Solid Waste Management Action Plan, Volume 1, Portland, Oregon, October 1973.

3. Bay Area Solid Waste Management Project - Phase 1, State Solid Waste Management Board, February 1977.

4. Solid Wastes, Engineering Principles and Management Issues, Tchobanoglous/Theisen/Eliassen, 1977.

Table F-3. Estimated Composition of Municipal, Commercial and Industrial Wastes

Component	Municipal[a]	Commercial and industrial[b]	Combined total[c]
Paper			
Newsprint	9.0	5.0	7.0
Corrugated	5.0	35.0	20.0
Mixed paper	32.0	25.0	28.5
Subtotal, paper	46.0	65.0	55.5
Plastics	2.0	3.0	2.5
Rubber, leather, textiles, wood, etc.	4.0	8.0	6.0
Food waste, yard trimmings	24.0	5.0	14.5
Total combustibles	76.0	81.0	78.5
Metals			
Ferrous	7.0	4.5	5.75
Aluminum	0.7	0.3	0.50
Other nonferrous	0.3	0.2	0.25
Subtotal, metals	8.0	5.0	6.5
Glass and ceramics	9.0	8.0	8.5
Rocks, dirt and miscellaneous	7.0	6.0	6.5
Total noncombustibles	24.0	19.0	21.5

[a]From Table C-1, Reference a.
[b]From Table E-2, Reference a.
[c]Averaged value.

APPENDIX G

MARKETS FOR MATERIALS RECOVERED FROM SOLID WASTE

APPENDIX G

MARKETS FOR MATERIALS RECOVERED FROM SOLID WASTE

A primary concern in selling the materials recovered from solid waste is first separating the recovered materials as cleanly as possible from the combined mass of wastes. The cleaner the recovered materials are the higher the revenues they will yield in the materials market. The American Society for Testing and Materials (ASTM) is currently drafting standards on quality requirements for recovered materials and methods for sampling. It is estimated that these widely used standards will be available in three to five years.

The market analysis completed here is limited by the contract work scope to an update of previously completed studies. A market study completed in 1976 by the University of California, Berkeley, has the most current data for Alameda County. Therefore, data from that study have been used extensively in this appendix, either through direct quotation or by adaptation.

The first section of this appendix contains a discussion of recovery rates and quantities. The following sections contain an assessment of the markets available for recovered paper, ferrous and nonferrous metals, glass, refuse-derived fuel and energy produced from solid wastes.

RECOVERY RATES AND QUANTITIES

Most of the machinery and equipment used in resource recovery facilities have been widely used in the mining, ore beneficiation, food processing, and lumber industries. Presently, there are resource recovery facilities in St. Louis, Ames, Milwaukee, Chicago, San Diego and New Orleans that are demonstrating the feasibility of recovering materials from solid waste streams.

Table G-1 presents the estimated quantities of the various components of solid waste generated in Alameda County for the years 1977, 1985 and 1995. Table G-2 presents a summary of the methods of material separation and the range of recovery rates that can be expected by various methods of separation. There is a range of rates for recovering material from solid waste since the recovery equipment and production data are based on experiments, pilot plant operations and full-scale applications.

Table G-1. Estimated Quantities of Various Components of Solid Waste

Component	Composition, percent[a]	1977 tons/day	1977 tons/year[b]	1985 tons/day	1985 tons/year[b]	1995 tons/day	1995 tons/year[b]
er							
ewsprint	7.0	160	58,400	180	65,700	220	80,300
orrugated	20.0	450	164,300	530	193,500	630	230,000
ixed paper	28.5	635	231,800	750	273,800	900	328,500
total paper	55.5	1,245	454,500	1,460	533,000	1,750	638,800
stics	2.5	60	21,900	70	25,600	80	29,200
ber, leather, textiles nd wood	6.0	130	47,500	160	58,400	190	69,400
d waste and ard trimmings	14.5	320	116,800	380	138,700	460	167,900
total combustibles	78.5	1,755	640,700	2,070	755,700	2,480	905,300
als							
errous	5.75	130	47,500	150	54,800	180	65,700
luminum	0.50	10	3,700	15	5,500	15	5,500
ther nonferrous	0.25	55	1,800	5	1,800	10	3,700
total metals	6.5	146	53,000	170	62,100	205	74,900
ss and ceramics	8.5	190	69,400	220	80,300	270	98,600
ks, dirt and iscellaneous	6.5	140	51,100	170	62,100	205	74,800
total noncombustibles	21.5	475	173,500	560	204,500	680	248,300
al	100.0	2,230	814,200	2,630	960,200	3,160	1,153,600

om Table F-3.

5 days per year.

Table G-2. Summary of Methods of Separation

Product	Method of separation	Recovery rate[a], percent	Status of technology
Paper scrap	Source separated	10 - 15	Well developed
Metals			
Municipal ferrous scrap (MFS)	Mechanically separated	98 - 99	Well developed
Municipal aluminum scrap (MAS)	Mechanically separated	49 - 75	Developing
Other nonferrous scrap (ONFS)	Mechanically separated	66 - 80	Developing
Glass, mixed color	Mechanically separated	63 - 73	Developing
Refuse derived fuel	Mechanically separated	80 - 95	Developed

Source: New Orleans Resource Recovery Facility Implementation Study.

[a] $\frac{\text{Amount of component recovered}}{\text{Amount of component in total waste stream}} \times 100$

Table G-3. Recoverable Quantities of Solid Waste in Alameda County

Component	Recovery rate[a], percent	Quantities, tons/year		
		1977	1985	1995
Paper[b]	10[b]	45,000	53,000	64,000
Ferrous metal	98	47,000	54,000	64,000
Municipal aluminum scrap	49	2,000	3,000	3,000
Other nonferrous	66	1,000	1,000	2,000
Glass	63[c]	44,000	51,000	62,000
Refuse derived fuel[d]	80	513,000	605,000	724,000

[a] $\frac{\text{Amount of component recovered}}{\text{Amount of component in total waste stream}} \times 100$

[b] Based on source separation program.

[c] Recovery rate is based on recovering only glass from the glass and ceramic fraction.

[d] Based on mechanical separation of combustible fraction and the assumption that a strong source separation program for paper does not appreciably alter the quantities of combustible materials given in Table G-1.

The recovery rates and recoverable quantities used for Alameda County are shown in Table G-3. This data has been selected from the New Orleans Recovery I Implementation Plan as the most representative but it should be used with caution because of its limited demonstrated application. More accurate data on the efficiencies of various separation equipment should be available within three years as a result of the operation of the New Orleans and other resource recovery facilities.

RECOVERED PAPER

The three main constituents of the paper component of the solid waste stream are newsprint, corrugated and mixed paper. The potential markets for these recycled items have been summarized from Reference 2 and are discussed below.

Markets

There are two primary markets for recycled paper; one is for reuse as a fibre for new paper production, the other is for use as thermal insulation.

Reusable Fibre. The paper stock industry is and has been recycling both newsprint and corrugated. However, there is a large amount of mixed paper which has a high fibre content which has not been recycled. The mixed paper consists of printing and writing paper, magazines, mail discards, computer paper and cards, food packaging waste, tissues, and small amounts of corrugated material and newsprint. This stream has, up to this point, remained largely unrecovered.[2] The main problem in recovering paper for reuse as fibre is that once paper is discarded to the waste stream it absorbs moisture which degrades its quality. To avoid this product degradation, paper which is to be reused would have to be bundled at the point of discard and transferred to the recovery site without being mixed with the rest of the waste stream. If the bundles remained intact and uncontaminated, they could be removed at the tipping area and/or at a location in the resource recovery plant. Thus, recycled paper is most valuable when a source separation program is in effect.

Thermal Insulation. Cellulose insulation is being produced using recycled newsprint and small amounts of corrugated material and magazines. Since the material is combustible, a fire retardant must be added. The paper must be dry or the fire retardant chemicals will not adhere. There are presently over 30 manufacturers of cellulose insulation in California. The main problem in reusing paper for insulation is that the manufacturers cannot tolerate moisture absorbed by the paper. Therefore, paper that would be recycled to this industry would also best be supplied from a source separation program.

Upgraded Paper Fibre. A new process has recently been successfully tested which mechanically removes paper fibre from the solid waste stream. This product has been tested and shown to be a high quality pulp substitute. This process is not yet commercially proven but it represents the most promising technique for recovering paper from the combined waste stream.[2]

Customers and Prices

Table G-4 presents the past and present value of the three types of recovered paper products. These prices are based upon the newsprint and corrugated being banded on pallets and mixed paper being baled. Past experience has shown that materials sold directly to a reuser on a long-term contract can receive prices higher than those shown. Cellulose insulation manufacturers generally pay a $2-$3 per ton premium on the prices shown in Table G-4.

The following list of potential Bay Area customers for paper was taken from Reference 2, where further information and discussion is available.

- Independent Paper Stock Company - Oakland and San Francisco
- Consolidated Fibres, Inc. - Richmond, California
- Garden State Paper Company - Los Angeles, California
- Bay City Paper Stock Company - San Leandro, California
- Sonoco - Richmond, California
- Certain Teed Products - Richmond, California
- Kaiser Gypsum Company - Richmond, California
- Container Corporation of America - Santa Clara, California
- Mono-Therm Insulation Systems - Oakdale, California

Value of Recovered Paper

The estimated value of the paper components in the waste quantities for 1995 is $1,310,000. This value is based on the asumption that a source separation program could be effected and achieve a 10 percent recovery rate and that the price will remain at 1978 levels. A breakdown of the value of individual components is presented in Table G-5.

Table G-4. Paper Prices

Material	Price quoted by buyers dollars/ton		
	1973 to 1974	1976	1977
Newsprint	2.00 to 34.0	22.0	30.0
Corrugated	5.0 to 40.0	25.0	25.0
Mixed paper	10.0 to 20.0	10.0	15.0

Source: Reference 2, and Brown and Caldwell.

Table G-5. Estimated Value of Recovered Paper

Component	Quantity, 1995 tons/year	Recovery rate, percent	Quantity recovered, tons/year	Price, dollars/ton	Total annual value, dollars
Paper					
Newsprint	80,000	10	8,000	30.00	240,000
Corrugated	230,000	10	23,000	25.00	575,000
Mixed paper	328,500	10	33,000	15.00	495,000
Totals	638,800	-	64,000	-	1,310,000

RECOVERED MUNICIPAL FERROUS SCRAP (MFS)

Removal of ferrous metals from the solid waste stream is perhaps the most well-developed technology in solid waste processing today. Recovery rates greater than 98 percent of the ferrous metal fraction can be achieved if two magnetic separator systems are in the processing train. After removal, ferrous metals undergo additional processing in order to remove the majority of entrapped organics. Two separate salable products are produced from the ferrous stream, the light ferrous fraction (LFF) and the heavy ferrous fraction (HFF). LFF consists mostly of steel "tin" cans and other forms of light gauge steel sheet. The HFF consists of shredded items such as auto parts, bicycles, castings, bars, rods, pipes, ball bearings, bolts and nuts.

The LFF comprises anywhere from 50 to 90 percent of the ferrous metals in the solid waste stream. EPA estimates the composite of the MFS as 50 percent LFF, 16 percent discarded appliances (commonly known as oversize bulky wastes or OBW) and 34 percent HFF. Since the EPA estimates are based on both residential and commercial wastes, they are applicable to this study. The discarded appliances are included in the LFF portion of the ferrous metals. In this study, the LFF is assumed to be 66 percent of the total ferrous component, and the HFF is assumed to be 34 percent of the total ferrous component.[5]

The ASTM is currently drafting chemical composition specifications for MFS for the various industries which purchase recovered material. Until these new specifications are completed, there are only traditional scrap classifications. These are presented in Table G-6.

The LFF appears to be suited to Code No. 214, No. 3 bundles; however, most scrap dealers prefer not to work with this category but attempt to characterize the LFF with Code No. 209, No. 2 bundles with a value comparable to some percentage of them.[2] The HFF can be characterized as either Code No. 200, No. 1 heavy melting steel, or Code No. 209, No. 2 bundles.

Markets

The markets for municipal ferrous scrap (MFS) are described in Reference 2. The descriptions have been adapted for presentation here. Generally, four market categories exist for municipal ferrous scrap. These markets, consistent with the previously discussed specifications, are remelt, detinning, copper precipitation and secondary metal dealers.

Table G-6. Institute of Scrap Iron and Steel (ISIS), Inc., Partial Listing of Scrap Iron Grades

ISIS Code Number	Classification: Description
200	No. 1 Heavy Melting Steel: Wrought iron and/or steel scrap 1/4 inch and over in thickness. Individual pieces not over 60 x 24 inches prepared in a manner to insure compact charging.
209	No. 2 Bundles: Old black and galvanized steel sheet scrap, hydraulically compressed to charging box size and weighing not less than 75 pounds per ft^3. May not include tin or lead - contact material or vitreous enameled material.
213	Shredded Tin Cans for Remelting: Shredded steel cans tin coated or tin free, may include aluminum tops but must be free of aluminum cans, nonferrous metals except those used in can construction and nonmetallics of any kind.
214	No. 3 Bundles: Old sheet steel compressed to charging box size and weighing not less than 75 pounds per ft^3. May include all coated ferrous scrap not suitable for inclusion in No. 2 Bundles.
215	Incinerator Bundles: Tin can scrap, compressed to charging box size and weighing not less than 75 pounds per ft^3. Processed through a recognized garbage incinerator.

Source: Reference 2. ISIS Bulletin "Specification for Iron and Steel Scrap", 1975.

Remelt. There are three industries in this category: iron and steel foundries, iron and steel product manufacturers and the ferroalloy industry; all of the industries would be primarily interested in the HFF. The scrap quality, i.e., the residual alloys and other contaminants, is of prime importance because of the type of furnace being used. The various types of furnaces which are located in Alameda County are summarized below:

- Open hearth furnaces produce steel and normally use about 45 percent scrap in their charge. Open hearth furnaces are operated by Pacific States Steel in Union City.

- Electric furnaces produce cast iron and steel from essentially a 100 percent scrap charge. A furnace of this type is operated by Judson Steel in Emeryville.

- Cupola furnaces are used in the iron casting industry, and can utilize approximately 85 percent scrap in the charge. Cupola furnaces are operated by Phoenix Iron Works in Oakland.

Detinning. The detinning of ferrous scrap is the major domestic source of tin. Detinners can accept the light ferrous metal recovered from solid waste (LFF). After detinning, the ferrous by-products can be used for precipitating copper from copper ore. There are two detinning operations in California which would be interested in purchasing recovered material. Adherence to certain specifications is required. Briefly these are:

- Scrap must be 95 percent ferrous metal and should be free of garbage, paper, and plastics

- Scrap must not contain more than 4 percent aluminum

- Bulk density should be 25 lb/cu ft

- Size shall be 95 percent -6 in., +1/2 in.

- Scrap should not be balled, nuggetized, burned or incinerated

The detinning operations are discussed in the section on customers and prices.

Copper Precipitation. Copper mines located in the western United States use ferrous scrap to precipitate copper. The high

percentage of cans in LFF makes this material an ideal feedstock for copper precipitation. The following specifications must be adhered to:

- Scrap must contain a minimum of 96 percent by weight iron
- Maximum combustibles shall be 0.2 percent
- Scrap shall be processed free of combustibles by burning, chemical detinning, etc.
- Bulk density shall be 30 lbs per cu ft
- Scrap shall not be baled or balled

Because of historical market pressures, it is not considered feasible to sell scrap directly to the copper mines. The primary customer for the LFF which would probably sell to the copper precipitation industry is discussed under customers and prices.

Secondary Metals Dealers. The scrap dealer who purchases materials and resells them to mills and foundries is the principal secondary metals dealer. The Bay Area is a major point of departure for exported scrap. Dealers here are not familiar with municipal ferrous scrap as a resalable product to mills, thereby motivating direct sales by recovery agencies. However, dealers can serve as brokers and provide certain unique processing and transportation services.

Customers and Prices

The potential customers for each of the identified markets have, in some cases, developed specifications and indicated prices which they would pay for recovered ferrous metals.

Remelt. Three potential customers for this material were identified during market studies in Alameda County by the University of California, Berkeley.[2] The customer listings have been adapted from Reference 2 and are summarized here.

Judson Steel, Emeryville. This company's sole product is steel reinforcing bar. Judson operates an electric furnace and produces about 175,000 net tons/yr. Judson has conducted tests with ferrous scrap and has expressed interest in purchasing about 400 to 2,000 tons/mo of scrap depending upon the market conditions, scrap quality, etc. Reference No. 2 contains correspondence from Judson Steel on the acceptability of using the HFF and gives some

preliminary limits on the contaminants and indicates that the price would range from a low of the No. 2 bundle price to a high of the No. 1 heavy melting steel price.

Pacific States Steel Company, Union City. This company operates four open hearth furnaces with a yearly production in excess of 350,000 tons. The company has not had any experience with a refuse-derived scrap per se and would require a chemical analysis in order to evaluate its utilization. The critical tramp elements include copper, lead, zinc, nickel, sulfur and iron; however, organic contaminants such as paper and plastic are also of concern since they would cause an increase in lime consumption and air pollution. For an acceptable scrap, Pacific States Steel would tie the price to a published market quotation, (e.g., the No. 1 heavy melting steel price). Pacific States Steel could conceivably purchase 150,000 tons/yr of scrap.

Phoenix Iron Works, Oakland. This is a foundry operation which has conducted tests with municipal ferrous scrap. They found that aluminum is the worst contaminant for their product since it creates a porous casting. They indicate that for low grade, nonductile products, a high scrap charge would be possible. Phoenix Iron Works has not indicated any prices which it would be willing to pay for ferrous scrap.

Detinning. The University of California, Berkeley study identified M and T Chemicals and Proler International as potential customers for detinning.[2] The data from Reference 2 were adapted for this study and are summarized here.

M and T Chemicals, Inc., South San Francisco. This company operates a detinning plant and has expressed interest in purchasing the light ferrous fraction (LFF). They are currently purchasing flattened tin cans collected at ecology centers in the Bay Area. For material meeting the specifications presented previously, M and T will pay $30/gross ton ($26.78/net ton) plus 50 percent of the amount by which No. 2 bundles exceed a specified price (as published in Iron Age magazine). The price quoted is FOB the detinning plant.

Proler International, Vernon, California. This company operates a detinning plant and would be willing to purchase light ferrous fraction (LFF). In the past, they have paid from $14.06 to $50.00 per gross ton depending upon cleanliness, freight costs, scrap prices and bulk density.

Copper Precipitation. Los Angeles By-Products Company operates can recovery facilities at landfills in Pacheco and Sacramento and at the SWETTS transfer station in San Francisco. The raw

scrap is processed by shredding, magnetically cleaning, and burning off organic materials and coatings. They presently process about 1,500 tons/mo from all sources. Their specification is for an unballed material. The most recent quoted price is $25 to $40/ton.

Secondary Metal Dealers. Schnitzer Steel Company in Oakland has worked with municipal ferrous scrap and has indicated an interest in purchasing municipal ferrous scrap at a price tied to the price for No. 2 bundles. Schnitzer is currently paying $25 to $30/net ton. Other secondary metal dealers in the area are Circosta Iron and Metal in San Francisco, Markovits and Fox in San Jose and the Learner Company in Oakland.

Value of Recovered Municipal Ferrous Scrap

Regardless of the specific markets selected, most of the prices for MFS are tied to Iron Age scrap prices. For this reason, the price given in Table G-7 for the HFF is the current price for No. 1 heavy melting steel and the price for the LFF is the current price for No. 2 bundles. The solid waste stream in Alameda County in 1995 has the potential to yield 64,000 ferrous tons/yr with a value of $2,980,000, assuming the price paid for materials holds as it is in 1978.

RECOVERED MUNICIPAL ALUMINUM SCRAP (MAS)

Although aluminum is only a small portion of the solid waste stream, it is the most valuable commodity in the waste stream. Not only does aluminum bring the highest price per ton of all the noncombustibles in the solid waste stream, it takes only 5 percent of the energy to produce a pound of aluminum from scrap as it does to produce a pound of aluminum from virgin resources.[7] This savings is not reflected in the current price structure for recovered aluminum. However, in this energy-conscious era, this is a strong incentive for recycling aluminum.

Beverage cans comprise approximately 68 percent of the total aluminum in the solid waste stream. Other items included in the stream are light foil, rigid foil, packaging, lawn furniture, castings, automobile parts, discarded siding, roofing, doors and windows.[7]

Markets

Since the late 1960s the major aluminum companies have had can recycling programs. Initially viewed as being mainly for public relations, these programs have grown in size and number to the point where now a significant number of cans are being recovered.

Table G-7. Estimated Value of Recovered Municipal Scrap Ferrous

Component	Recovery rate, percent	Recovered[a], tons/year	Price, dollars/ton	Total price per year
Light ferrous fraction (LFF)	98	42,000	39	1,638,000
Heavy ferrous fraction (HFF)	98	22,000	61	1,342,000
Totals	-	64,000	-	2,980,000

[a]From Table 6-1 and percentaged LFF - 66 percent
HFF - 34 percent.

The aluminum industry estimated an aluminum can recycle rate of about 25 percent for 1975. There are three general markets for recovered MAS; primary producers, secondary smelters, and scrap dealers. These markets have been identified in Reference 2, and the data from that report have been adopted and summarized here.

Primary Producers. The Aluminum Company of America (ALCOA), Reynolds Metals, and Kaiser Aluminum are the three major primary producers of aluminum in the United States. These companies are all involved with the reduction of ore and production of ingots and fabricated shapes. All three companies operate aluminum recycling programs and have expressed interest in negotiating long-term contracts for the purchase of a refuse-derived aluminum scrap consistent with their specifications.

The best market for the MAS product is with the primary producers, where it is processed into Remelt Scrap Ingots (RSI).[8] In order for these ingots to be usable in as many applications as possible, the concentration of impurities such as iron, zinc, tin, lead, silicon and copper must be controlled. For this reason the specifications developed by the primary producers are divided into grades based upon chemical composition, which determines the economic value. This chemical analysis is performed on the melted material by assay of each shipment.

The ASTM is presently developing specifications, sampling and assay methods for municipal aluminum scrap. The three major aluminum production companies, however, have already developed their own specifications for this material. Reynolds has developed a standard specification for a "Grade A" and a "Grade B" scrap aluminum. ALCOA has also established two grades of aluminum from MAS. The chemical analyses requirements for these grades are given in Table G-8. Kaiser has developed six quality variations for aluminum from MAS but has not yet applied prices to the six grades.[8]

Secondary Smelters. Smelters usually buy scrap and process it into secondary ingots. Traditionally all aluminum scrap has been used by secondary smelters to make casting alloy. The majority of smelters in California are located in the Los Angeles area; however, there are two smelters in the Bay Area, Custom Alloys and Globe Metals, who are discussed later under Customers and Prices.

Scrap Dealers. A resource recovery facility producing a consistent quantity of MAS would probably sell directly to the primary producers or secondary smelters. However, under certain conditions, scrap dealers could be a market. For instance, both Learner Company and Associated Metals Co. in Oakland operate sweat furnaces in which aluminum is selectively sweated from an aluminum-ferrous mix. Some of the scrap dealers are getting

Table G-8. Chemical Analyses for Aluminum Scrap, Maximum Percent by Weight

Element	Reynolds metals		ALCOA	
	Grade A	Grade B	Grade I	Grade II
Silicon	0.30	0.50	0.30	1.00
Iron	0.60	1.0	0.70	1.00
Copper	0.25	1.0	0.40	2.00
Manganese	1.25	1.25	1.50	1.50
Magnesium	2.0	2.0	2.00	2.00
Chromium	0.1	0.3	0.10	0.30
Nickel	0.05	0.3	N.A.	N.A.
Zinc	0.25	1.0	0.25	2.00
Titanmium	0.05	0.05	0.08	0.30
Bismuth	0.02	0.3	N.A.	N.A.
Lead	0.02	0.3	0.04	0.50
Tin	0.02	0.3	0.04	0.30
Others				
Each	0.04	0.05	0.04	0.04
Total	0.12	0.15	0.12	0.12
Aluminum	Remainder	Remainder	Remainder	Remainder

Source: Reynolds metals and ALCOA.

Table G-9. Prices of Municipal Aluminum Scrap

Unit	Reynolds metals			ALCOA	
	Analysis no. 1	Analysis no. 2	Analysis no. 3	Grade I	Grade II
Dollars/pound	0.225	0.19	0.15	0.277	0.227
Dollars/ton	450	380	300	554	454

fairly sophisticated in their processing, so it is probable that an unprocessed nonferrous mix could be sold to a scrap dealer. Although the price for such a product would be low, the refuse processing plant would not have to install aluminum recovery equipment.

Customers and Prices

There is no specific published market history for MAS; however, there are opportunities to sell MAS to customers in each of the markets discussed previously.

Primary Producers. All three major aluminum companies operate aluminum recycling programs, and each has stated they would negotiate long-term contracts for the purchase of a refuse-derived aluminum scrap.

Table G-9 indicates the prices that Reynolds Metals is going to pay for materials from the Recovery I facility in New Orleans and what Alcoa will pay per their pricing formula. All prices are FOB the resource recovery plant.

The relatively low prices which Reynolds Metals is paying reflect a different set of chemical requirements than presented in Table G-8. The elemental composition in Table G-8 was developed after the contract was signed. It is expected that Reynolds Metals would pay a price for Grades A and B that would be similar to the price ALCOA is willing to pay for Grades I and II.

Currently the primary producers are paying $0.17/lb for recycled aluminum cans from ecology centers. The higher prices indicated above reflect the higher prices a resource recovery facility can command because of the larger tonnages of aluminum involved and the stability of the source.

Secondary Smelters. The University of California, Berkeley study identified two potential secondary smelter markets in Alameda County. The data on each have been adapted from Reference 2 and summarized here.

Custom Alloys and Globe Metals of Oakland are two aluminum smelters in the Bay Area with capacities of 1.7 million and over 2 million pounds per month, respectively. Both have expressed a willingness to purchase a refuse-derived scrap at a price tied to old sheet prices as published in the American Metal Market. Their chemical composition requirements are quite liberal.

Vulcan Materials in Southern California will also purchase a refuse-derived scrap material meeting either Reynolds Grade A or Grade B requirements.

Most smelters agree that any reasonable grade of aluminum scrap could be sold at a price commensurate with its quality. There is essentially no competition between primary producers and secondary smelters.

Scrap Dealers. If MAS was sold directly to scrap dealers, the prices would probably be similar to the price paid by secondary smelters. Markovitz and Fox in San Jose is a potential customer for aluminum cans. They have a large and modern aluminum beverage can processing system. Prices paid by scrap dealers would be less than the price paid by the primary dealers.

Value of Recovered Municipal Aluminum Scrap

There will be approximately 3,000 tons/yr of recoverable aluminum in the Alameda County waste stream in 1995. Based on ALCOA's price of $454/ton for Grade II aluminum, the value of this material is approximately $1,362,000 per year.

RECOVERED NONFERROUS SCRAP OTHER THAN ALUMINUM

Other nonferrous metals scrap (ONFS) is a mixture of red and white metals, principally copper and zinc and alloys with small quantities of brass and lead.[1]

The primary market for ONFS is scrap dealers who can separate the constituents of this stream. Markovitz and Fox Co. is one potential local market. Reynolds Metals Co. has agreed to buy a mixture of copper, zinc and aluminum from the Bridgeport, Connecticut, facility at a price of $0.12/lb or $240/ton. Assuming this 1978 price, the 2,000 tons/yr of recoverable ONFS in the Alameda County waste stream in 1995 has a potential value of approximately $480,000.

RECOVERED GLASS SCRAP

The market discussions for recovered glass scrap have been adopted from Reference 2 and summarized here.

Glass plants are located close to the consuming market and are concentrated in ten states, one of which is California. There are three basic categories of product: containers, which account for roughly 73 percent of the total glass production; pressed and blown glass, which comprises about 12 percent of the total glass production; and flat glass, which accounts for about 15 percent of the total glass manufactured.

Container glass makes up about 9 percent of the mixed municipal refuse stream while pressed and blown glass and flat glass each contribute about 0.5 percent. The glass stream has a color balance of approximately 67 percent clear and 33 percent green and amber.

Markets

Scrap glass can be used in the manufacture of new glass products, primarily glass containers, or as a raw material for manufacture of other products.

Glass Container Manufacturers. This is the largest market for recovered glass scrap. The main problem with reusing recovered glass scrap is that only manufacturing plants which produce green and amber glass can use a mixed color cullet (broken glass), and then the percentage of cullet used in the feed is limited by the color of the cullet. The Glass Packaging Institute (GPI) has developed tentative specifications for glass from resource recovery systems. These specifications are presented in Table G-10. As manufacturers complete more evaluations of the effects of cullet contaminants, the specifications on refractory particles and color are expected to change. The ASTM is in the process of compiling a new set of specifications which may include different standards for optically or color sorted cullet and unsorted, beneficiated cullet.

A recent development is the possibility of the glass container manufacturers creating a new mixed color line of glass containers which would be capable of using large amounts of mixed color cullet for the feedstock. In order to avoid contamination of the other color lines, the manufacturers would probably have to install new furnaces, so this potential market is not currently available and is not considered further in this report.

Manufacturing Other Products. Cullet has been considered for use in a wide variety of applications other than glass container manufacture. The potential uses are summarized from Reference 2 as follows:

- For other forms of glass manufacture
- As a road building material in the form of glasphalt, slurry seal, and glass beads for reflecting paints
- In building materials which include foamed insulation, bricks, tiles--ceramic and terrazzo, building blocks, sewer pipe, and aggregate
- Various miscellaneous categories such as ground cover, trickling filters, glass polymer composites, jewelry, etc.

Table G-10. GPI Tentative Specifications for Glass from Resource Recovery Systems, 11/9/76

GLASS OF THIS QUALITY WOULD BE USABLE AS CULLET FOR GLASS CONTAINER MANUFACTURING. EACH GLASS MANUFACTURING COMPANY, HOWEVER, MAY RESERVE THE RIGHT TO ACCEPT OR REJECT THIS SPECIFICATION.

1. Glass from Resource Recovery Systems shall be soda lime glass and a representative sample must meet the following specifications to qualify the glass lot to be used for direct use in soda lime glass container manufacturing. Sample should be prepared and examined per GPI TSTM etc.

2. Specifications: The sample must not container more than the percentage fraction of each of the following contaminants based upon dry weight:

   2.1. Liquid---------------No drainage from sample, non-caking and free-flowing (see note in supplement).

   2.2. Screen Size----------0% retained on 2" mesh screen.

   15% maximum to pass through a U. S. series 140 mesh screen.

   2.3. Organic Substances---Total organics as measured per GPI Tentative . Test Methods shall not exceed 0.2% of dry sample weight.

   2.4. Magnetic Materials---0.05% of dry sample weight; no particle size shall exceed 1/4".

   2.5. Allowable Color Mix for Color-Sorted Glass

2.5.1.	Flint Glass* -	90-100%	Flint
		0-5%	Amber
		0-1%	Green**
		0-0.5%	Other Color
2.5.2.	Amber Glass -	90-100%	Amber
		0-10%	Flint
		0-10%	Green
		0-5%	Other Color
2.5.3.	Green Glass -	50-100%	Green
		0-35%	Amber
		0-15%	Flint
		0-5%	Other Color

*Flint glass containing over 0.1% Fe_2O_3 and/or 0.002% Cr_2O_3, as determined by chemical analysis, shall be considered mixed color glass.

**Flint glass can contain up to 1% emerald green or 10% Georgia green, or a combination within these limits. Note: (1% of Georgia green equals 0.1% emerald green.)

Table G-10. GPI Tentative Specifications for Glass from Resource Recovery Systems, 11/9/76 (continued)

2.6 Inorganic Material (non-magnetic metal, refractories, and other solid inorganics) - Total inorganics 0.1% of dry sample. No particle shall exceed 1/4".

2.6.1. Refractories - Based upon U. S. Series screen size and sample weight, the following refractory particle count will apply.

+20 mesh	1 particle per 40# sample. No particle shall exceed 1/4".
-20+40 mesh	2 particles per 1# sample.
-40+60 mesh	20 particles per 1# sample.

2.6.2. Non-magnetic metals

+20 mesh	1 particle per 40# sample. No particle shall exceed 1/4".

3.0 Soda-Lime Glass - This glass will have a limited composition range as follows:

SiO_2	66.0 to 75.0%
R_2O_3 (Al_2O_3)	1.0 to 7.0%
CaO + MgO	9.0 to 13.0%
Na_2O	12.0 to 16.0%

Supplement to 2.1. Liquid

"Non-caking and free-flowing." A moisture content of less than 0.5% by weight would probably be necessary to meet the free-flowing characteristic of a cullet which is predominately of small particle size (-16 U. S. series mesh).

Many of these products, although commercially feasible, have only been made on a laboratory scale. Few detailed studies are available which can provide guidance on the types and quantities of contaminants which are permissible. However, there are three markets which can be considered proven but at the moment are not cost-effective. These are discussed below.

Glasphalt. Cal-Trans is a likely customer for glasphalt. However; in 1976 the cost of Type B aggregate was $11.50/ton. Glasphalt requires the addition of hydrated lime (at $37/ton) to increase the adherence between glass and asphalt, so at the moment this is not a viable market in California. Glasphalt does increase the paving season because of its ability to retain heat, so glasphalt may be more cost-effective in colder climates than it is in California.

Slurry seal. Slurry Seal Corporation, Waco, Texas, manufactures a slurry seal using waste glass but the major problems are insufficient quantities of waste glass, and a cost disadvantage. Glass would have to be recovered for $3/ton to make the slurry seal competitive with conventional sealing mixes.

Secondary building products. There are many building products (panels, construction block, tiles, etc.) which could use recovered glass if it was available. Although specific prices are not available as yet, this market should not be completely dismissed.

Customers and Prices

Potential customers for recovered glass are discussed below. Since there are a number of customers available for using recovered glass for remanufacturing glass containers at an established price, the secondary market for using glass for manufacturing other products was not investigated to determine customers and prices.

Glass Container Manufacturers. The specific cullet customers in the Bay Area have been identified in Reference 2 and the data are quoted or adopted and summarized here.

- Anchor Hocking Corp., Oakland. Will accept only flint meeting the GPI specifications. Currently they can use approximately 5 tons per day of purchased cullet, at the price of $20/ton, with a maximum potential of 75 tons per day of purchased cullet.

- Brockway Glass Co., Inc, Oakland. Will accept only flint meeting the GPI specifications. Brockway offers $20/ton and has a capacity for accepting 0.5 tons/day.

- CIRCO, Fresno. CIRCO is a glass cullet broker and consequently the amount of cullet it can absorb depends upon the quantities that manufacturers are willing to buy. They are currently accepting mixed cullet with rings and caps which they process at the price of $21/ton, and have no present limit on daily tonnage.

- Gallo Glass Co., Modesto. Will accept only green and amber in large quantities, cleaned and crushed to approximately 3/4 in. Gallo uses roughly 12 tons/day of purchased cullet at the price of $20/ton.

- Glass Containers Corp., Antioch. Glass Containers currently could use 20 tons per day at the price of $20/ton for cullet meeting GPI specifications.

- Glass Containers Corp., Hayward. The Hayward plant pays as much as $21/ton and could potentially accept 230 tons/day of green cullet.

- Madera Glass Co., Madera. Madera Glass only makes emerald green. They are currently paying $20/ton to recycling groups for approximately 100 tons/day of glass bottles.

- Owens-Illinois, Oakland. Owens-Illinois is currently using an average of roughly 130 tons of cullet per day of which 20-26 tons is purchased. For material meeting GPI specifications, the Oakland plant is willing to pay $20/ton.

As the above list indicates, the only purchaser who will presently accept color mixed cullet is CIRCO in Fresno, California.

Value of Recovered Glass Scrap

It appears that the best potential market for glass scrap is the Glass Container Manufacturers, since they have the demand, capacity and willingness to use it.

The price of $20/ton appears to be consistent and has remained relatively unchanged. There will be approximately 62,000 tons per year of recoverable glass available in Alameda County in 1995 with a value of $1,240,000, assuming the price quoted for 1978 is used for 1995 quantities. It should be noted that because of the problem of using mixed color cullet as discussed previously there may not be a market available which can absorb all of this material.

REFUSE-DERIVED FUEL (RDF)

Refuse-derived fuel (RDF) is a combustible material that is produced by a resource recovery plant in conjunction with the processing required to remove the other recyclable materials. Generally, RDF consists of the combustible portions of solid waste such as paper, plastics and organics. In addition, depending upon the processing techniques, it may include small portions of inorganics such as fine glass and metals. The refuse-derived fuel can be used as a fuel source for equipment which uses a solid fuel such as coal, or as a supplemental fuel for incinerators or it can be used as a fuel for various energy production processes.

Presently, there are six resource recovery facilities producing RDF. The facilities are located in St. Louis, Missouri; Ames, Iowa; Chicago, Illinois; Milwaukee, Wisconsin; New Orleans, Louisiana; and Baltimore County, Maryland. The RDF from the Ames facility is being combusted in a utility boiler. The RDF from the rest of the facilities is being evaluated for combustion in a variety of systems. There are additional facilities in various stages of design and construction in Lane County, Oregon; Monroe County, New York; and Bridgeport, Connecticut. Thus, the feasibility of producing RDF is well established providing a market is available.

RDF Properties

Rigorous specifications for RDF have not yet been developed by fuel purchasers or testing organizations such as ASTM. However, certain physical and chemical factors that affect its use and marketability are known. These factors are ash content, moisture content, particle size and heating value.

Ash Content. Ash is the residue remaining after combustion. The composition and quantity of ash are both critical to the combustion process, since operating furnaces can be adversely affected by ash fouling and erosion. Since ash must be removed and hauled to a disposal site, there is a materials handling and disposal cost which increases as the ash content increases.

Moisture Content. Water does not yield energy in a traditional combustion system. Therefore, RDF should have as low a moisture content as possible prior to being fed into the combustion unit. Experience gained through traditional incineration operations shows an achievable moisture content of less than 25 percent for RDF.

Particle Size. Desirable particle size is set by the type of combustion unit. The extremes are represented by the need for RDF particles of 1/2 to 1 in. size for suspension burning units and

the need for no maximum size in a mass fired incinerator unit. Generally, processing costs increase as the RDF particle is reduced in size.

Heating Value (HV). The energy yield of RDF is expressed as its heating value. Commonly measured as BTU per pound of refuse-derived fuel, HV must be maintained at a high enough level to ensure the efficiency of the combustion units. Moisture content is a key determinant of heating value. Generally, processing costs to prepare RDF will increase as heating value is increased.

Table G-11 compares the characteristics of RDF produced at St. Louis and Ames with the estimated characteristics for RDF produced at New Orleans.

New Developments

The heating values shown in Table G-11 do not compare favorably with other alternate fuels such as western thermal coal at 10,800 Btu/lb or fuel oil at 33,000 Btu/lb. There are a number of developments now under way which indicate that RDF can probably be produced with heat values from 6,000 Btu/lb to 8,000 Btu/lb. These upgraded RDF heat values would certainly improve the marketability of RDF.

Another serious disadvantage that RDF has in comparison with competing fuels is its density. Typical RDF densities vary from 2 to 9 lbs/cu ft. This results in extremely high costs for transportation and handling. The density of the RDF can be increased by producing the RDF in pellets or briquets or by reducing the RDF to a powder.[13] These systems result in fuel densities from 35 to 40 lbs/cu ft. These increased densities reduce handling, storage and transportation costs, but do not increase the heating value.

These new developments indicate that RDF may someday be competitive with subbituminous coals in heat value and handling characteristics thus opening an immense market for RDF.

Markets

The main markets for RDF are the supplemental fuel market and as a feed source for energy production systems which may produce a pyrolytic oil or gas or some other form of energy. The energy production markets are described in the next section of this report, thus only the use of RDF as a fuel is discussed here.

The markets for RDF as a supplemental fuel for coal-fired processes in the Bay Area and for the entire state of California are very poor. Most full-scale resource recovery plants presently

Table G-11. Characteristics of RDF

Characteristic	Ames RDF[a]	St. Louis RDF[b]	New Orleans RDF[c]
Heating value, BTU/lb	5,700	4,900	5,500
RDF recovered, percent of as received municipal waste	85	81	81
Moisture, percent	23	27	25
Ash, percent wet weight	17	20	N.A.
Sulfur, percent wet weight	0.43	0.14	N.A.
Chlorides, percent wet weight	0.24	0.33	N.A.
Particle size, inches	1.5	1.5	4.0
Percent smaller than 1.5 in.	89	95	N.A.
Geometric mean diameter	0.47	0.29	N.A.

[a]Reference 10.

[b]Reference 9.

[c]Reference 1.

N.A. not available.

producing RDF are using or have used the RDF as a supplemental fuel for cofiring with coal in utility boilers. However, California does not have any existing coal-fired facilities. Existing fossil fuel plants are either oil or gas fired.

It is often difficult to convert or retrofit an oil or gas fired boiler to one which can burn a solid fuel, such as RDF or coal. Several cement manufacturers in California are retrofitting existing facilities to burn coal. On the national level ERDA has funded a test program at a cement plant in Texas to determine the feasibility of using RDF as a coal supplement.[1] The results of this project are not yet available. The main problem is that since the fuel is combusted inside the kiln in direct contact with the product, the ash becomes part of the product, thus affecting the properties of the cement. This study should determine the burning characteristics of RDF and the potential deleterious effects caused by residual glass and aluminum in the RDF.[1]

The best chance for the burning of solid fuels (coal or RDF) appears to be the new facilities to be constructed to meet national energy policies. Currently the only major coal-fired facility proposed for Northern California is the PGandE coal-fired electric generating station. This facility is presently in preliminary hearings before the California Energy Commission and cannot be considered as an existing facility.

There is a possibility of using RDF to increase the heat value of any material which is currently being incinerated. Some potential cofiring applications are for sewage sludge, hazardous waste material or other incinerated items. The problem with this potential use is the severe air pollution requirements in effect in the San Francisco Bay Area regarding the operation of incinerators. If the use of incinerators increases in the Bay Area, the potential market for cofiring RDF will improve markedly.

Customers and Prices

The primary potential customers for RDF in California are the cement manufacturers which are retrofitting their operations to utilize coal and the coal fired facility which PGandE is proposing to locate at one of three sites in California.

The cement manufacturers which are undertaking retrofit operations are the Calavaras Cement Company, Kaiser Cement and Gypsum, and Lone Star Industries. These potential customers were not contacted since the ERDA demonstration project in Texas has not yet determined the feasibility of using RDF for fuel in cement kilns.

PGandE is evaluating the feasibility of burning either agricultural wastes or RDF in its coal facility. As yet there has been no decision as to which supplemental fuel source would be

used. PGandE has taken the position that the supplemental fuel source must be competitive with the cost of alternative available fuels.

The City of Alameda, Bureau of Electricity, is completing a feasibility study on the generation of electricity from a waste as fuel project. The preferred fuel is an RDF and the project is keyed to preparing wastes that are available within Alameda County. This project should be closely monitored, since the benefits of a successful facility could be significant for the entire solid waste handling, transportation, processing and disposal system.

Currently the price for western thermal coal (Utah and Wyoming) delivered to the Bay Area is approximately $30/ton. Assuming a heat content of 10,000 Btu/lb, the value of the fuel content of the coal is $1.50/MM Btu. Based on a heat content of 6,000 Btu/lb for RDF and a fuel efficiency factor of 90 percent, the fuel value of the RDF is approximately $16/ton. Decreases in the moisture content and the amount of inert materials in the RDF will increase the heating value and improve the marketability of the RDF.

Value of RDF

Based on recovering 80 percent of the combustible fraction of the solid waste stream in Alameda County as given in Table G-1 for 1995 quantities and an assumed heat value of 6,000 Btu/lb, the recoverable RDF in the Alameda County waste stream could be worth approximately $11,200,000 in 1995, assuming the fuel value of RDF remains at the 1978 level. This assumes that any source separation project for paper which is in effect in Alameda County does not remove more than 10 percent by weight of paper products.

RECOVERED ENERGY

Potential markets for energy produced from solid waste are examined in this section. Recent market studies are updated to the point where potential end users of energy are identified, estimated energy demands are established, and approximate prices for the energy forms considered are determined.

Available Markets

A variety of energy forms or end products are available from waste-to-energy conversion processes, including electricity, steam, pyrolytic gas, pyrolytic oil, ammonia, methanol and other synthetic chemicals. The risks, both technological and economic, associated with the production of such forms of energy as pyrolytic oil,

methanol, ammonia and other synthetic chemicals are too uncertain to justify even a superficial study of markets and marketing strategy. However, with the exception of pyrolytic oil, these chemicals are standard items of commerce and are easily transported and stored. Consequently, should the technology and economics of chemical production evolve to provide acceptable levels of risk, the market analysis will be a simple matter. In other words, the market can absorb any conceivable quantity of refuse-derived chemicals at some price. This is probably true of pyrolytic oil except that its composition and combustion properties may vary from process to process and consequently its market value will also vary.

Electricity. An energy recovery facility using RDF as fuel can produce approximately 0.3 kWhr per pound of RDF. This represents a generating capacity of 25 Kw per daily ton of RDF processed. Roughly 10 to 25 percent of the electricity generated is required for the process itself, leaving 19 Kw per daily ton of RDF that can be marketed. For a 1,000 TPD plant, this amounts to 19 MW and for a 2,000 TPD plant, 38 MW.

The demand for electricity is increasing and although the rate of increase may not be as great in the future as it presently is, there is little doubt that the market for electricity will increase. Pacific Gas and Electric Company (PGandE) is the major producer and distributer of electricity in Alameda County. The City of Alameda's Bureau of Electricity operates the electrical distribution system in the City of Alameda and is currently proposing to build a power plant which would be fueled with RDF. If this plant is successful in obtaining the necessary operating permits, it will represent a major market for RDF. Either PGandE or the Alameda Bureau of Electricity is a potential customer for electricity.

Gas. The available markets for gas generated by pyrolyzing RDF will vary depending on the composition and heating value of the gas. The pyrolytic processes which use air produce a gas with a heating value of 100-200 Btu/sdcf (standard dry cubic foot). Processes which use pure oxygen produce a gas with a heating value of 300-400 Btu/sdcf. These values can be compared to natural gas which has a heating value of approximately 1000 Btu/sdcf. Approximately 14 cu ft of pyrolytic gas with a fuel value of 300 Btu/sdcf can be generated from each pound of RDF. The main markets for pyrolytic gas are the existing gas purveyor in Alameda County, PGandE, and large consumers of natural gas.

Pyrolytic gas contains high concentrations of carbon monoxide and hydrogen. These constituents present severe safety hazards on the transportation and distribution of the pyrolytic gas. Carbon monoxide is odorless and toxic and can be a serious problem in

residential areas if a pipe were to leak or break. The hydrogen in the pyrolytic gas burns with an invisible flame which also presents serious safety problems. Thus any distribution system for pyrolytic gas should involve minimal piping distances and should not traverse residential areas.

Markets for pyrolytic gas would involve the use of existing equipment designed for burning natural gas or a fuel oil. Substituting pyrolytic gas with a heating value of 100-200 Btu/sdcf would present serious technical problems and would cause the efficiencies of existing burners and heat recovery systems to decrease, perhaps to undesirable levels. Thus no market has been identified for the use of pyrolytic gas with a low heating value. A pyrolytic gas with a heating value of 300 to 400 Btu/sdcf could be utilized directly in existing equipment without a significant decrease in overall process efficiency.

Steam. Steam can be used for space heating or cooling, process heating, drying, air compression and cleanup. Many of the large gas customers produce steam and are thus potential steam customers. The major customers are discussed below under Customers and Prices.

Customers and Prices

Specific customers and potential prices for each of the energy products discussed above are presented. It should be noted that firm commitments to accept any of the energy products have not been made.

Electricity. PGandE and the City of Alameda's Bureau of Electricity are the main potential customers for electricity. Presently PGandE is paying \$0.015 to \$0.03 per kWhr for power from various sources within their service area. The Bureau of Electricity is paying \$0.032 per kWhr for power from PGandE. Based on this range of prices, a price of \$0.03 per kWhr has been assumed for the value of electricity generated and sold to either PGandE or the Bureau of Electricity.

Gas. Potential gas customers are PGandE and large industrial customers in Alameda County. The largest gas users in the county include the General Motors Corporation in Fremont, Pacific States Steel Corporation in Union City, the University of California at Berkeley, the Alameda Naval Air Station and several glass companies in the northwestern part of the county.

The combined 1974 demand by U.C. Berkeley and the Alameda Naval Air Station amounted to some 165×10^9 Btu/mo, which is roughly equivalent to the use of all the pyrolytic gas which can be produced from a 650 TPD plant. The steel and glass companies in northwestern Alameda County used almost 350×10^9 Btu/mo which

is equivalent to the use of all the gas from a 1,400 TPD facility. Based on a current price of \$0.25 per therm (100,000 Btu) or 2.50 per 1,000 cu ft for natural gas, the value of pyrolytic gas with a heat content of 300 Btu/sdcf is \$0.75/1000 ft^3 neglecting the extra cost for compression.

Steam. The two largest industrial steam users in Alameda County are the Alameda Naval Air Station and the University of California at Berkeley (U.C.B.). The Naval Air Station uses an average 6.7×10^{11} Btu/yr for producing steam at 100 psi. The university uses 9.5×10^{11} Btu/year, producing steam at 120 psi. These two customers can therefore take 16.2×10^{11} Btu/year in steam demand. However, these two steam consumers are not close to each other. The U.C.B. requirement could be met with a facility with a capacity of 300 to 400 TPD of RDF. The Naval Air Station requirement could be met with a 225 to 300 TPD facility. Most of the other potential steam customers are widely dispersed and the construction of various steam plants large enough to satisfy their needs and still take advantage of the economics of scale will probably not be feasible.

Based on a value of natural gas of \$0.25 per therm and a steam generating efficienty factor of 80 percent, the value of produced steam is approximately \$3.15/MMBtu.

Value of Recovered Energy

As indicated earlier, the estimated quantity of RDF recoverable in the county in 1995 will be 724,000 tons. The possible revenues that could be obtained for sale of energy derived from processing this quantity of RDF are presented in Table G-12. These revenues are based on the prices determined for 1978 conditions.

On the basis of an energy price of \$2.50/MMBtu for a pipeline quality gas, the value of the recovered gas from 3,300 TPD of solid waste will amount to approximately 15.3 million dollars per annum. Steam would produce approximately 27 million dollars. However, sale of electricity would amount to only about 9.6 million dollars per year because of the resale value of \$0.03 kWhr and because about 25 percent of the energy produced is consumed in to the process.

SUMMARY OF VALUE OF RECOVERED MATERIALS

The potential values of recoverable materials in the Alameda County solid waste stream are presented in Table G-13 for the years 1977, 1985 and 1995. The cost-effectiveness of recovering these materials is discussed in Appendix H. The cost-effectiveness of recovering energy is discussed in Appendix I.

Table G-12. Value of Energy Recovered From Processing 724,000 tons/year of RDF

	Net production	Unit price, dollars	Total revenue, millions of dollars
Electricity	3.2×10^8 kWhr/year	0.03/kWhr	9.6
Steam	7×10^6 MM BTU/year	3.15/MM BTU	22
Pyrolytic gas	6.1×10^6 MM BTU/year	2.50/MM BTU	15.3

Table G-13. Value of Potentially Recoverable Material and Energy From the Alameda County Solid Waste Stream

Component	Unit value[a]	1977		1985		1995	
		Recoverable quantity[b]	Potential annual value[c]	Recoverable quantity[b]	Potential annual value[c]	Recoverable quantity[b]	Potential annual value[c]
Material							
Paper	d	45,000	930	53,000	1,090	64,000	1,300
Ferrous scrap	e	47,000	2,200	54,000	2,500	64,000	3,000
Municipal aluminum scrap	454	2,000	910	3,000	1,400	3,000	1,400
Nonferrous scrap, other than aluminum	240	1,000	240	1,000	240	2,000	480
Glass	20	44,000	880	51,000	1,020	62,000	1,200
Refuse derived fuel	16	513,000	8,200	605,000	9,700	724,000	11,600
Energy							
Electricity	0.03[f]	2.3×10^{8}[g]	6,900	2.7×10^{8}[g]	8,200	3.2×10^{8}[g]	9,600
Pipeline gas	2.50[h]	1.4×10^{10}[i]	10,800	1.7×10^{10}[i]	12,800	2.0×10^{10}[i]	15,300
Steam	3.15[h]	4.9×10^{6}[j]	15,500	5.8×10^{6}[j]	18,300	7.0×10^{6}[j]	22,000

[a]Dollars/ton unless noted.

[b]Tons/year unless noted.

[c]Thousands of dollars.

[d]Cost are based on $30/ton for newsprint, $25/ton for corrugated, $15/ton for mixed paper.

[e]Based on $39/ton for LFF; LFF = 66 percent of ferrous scrap.
$61/ton for HFF; HFF = 34 percent of ferrous scrap.

[f]Dollars per kWhr.

[g]kWhr/year.

[h]Dollars per MM BTU.

[i]Cubic ft of gas with a heating value of 300 BTU/sdcf.

[j]MM BTU.

REFERENCES

1. New Orleans Resource Recovery Facility, Implementation Study, National Center for Resource Recovery, Inc., Sept. 1977.

2. Market Potential of Materials and Energy Recovered From Bay Area Solid Wastes, University of Calif Berkeley, College of Engineering, March 1976.

3. Y.M. Garbe and S.J. Levy, Resource Recovery Plant Implementation: Guides for Municipal Officials-Markets, Washington D.C.: U.S. EPA, Office of Solid Waste Management Programs, 1976.

4. A Resource Recovery Case Study...IHE I-95 Complex, N.C.R.R. Bulletin, Summer 1976.

5. Aluminum Recovery...A Status Report, N.C.R.R. Bulletin, Spring 1977.

6. Introduction to Aluminum in Waste and its Recovery, Aluminum Recovery Workshop Dec. 7, 1977, V.F. Binkley, Kaiser Aluminum and Chemical Corporation, Center for Technology, Pleasanton, CA.

7. Midwest Research Institute, St. Louis Demonstration Final Report, U.S.E.P.A., EPA-600/2-77-155A, Sept. 1977.

8. Iowa State University & Midwest Research Institute, Evaluation of the Ames Solid Waste Recovery System, Part I, U.S.E.P.A.

9. Bogot, A. and Sherrill, R., Principal Aspects of Converting Steam Generators Back to Coal Firing, NCA/BCR Coal Conference and Expo II, Louisville, Kentucky, Oct. 21-23, 1975.

10. Solid Waste Resource Recovery Full-Scale Test Report, Brown and Caldwell, March 1977.

11. National Center for Resource Recovery, Inc., "Densified Refuse-Derived Fuel," NCRR Bulletin, Vol. VI, No. 1 (Winter 1976), pp. 4-9.

APPENDIX H

RESOURCE RECOVERY FACILITY ANALYSIS

APPENDIX H

RESOURCE RECOVERY FACILITY ANALYSIS

Small resource recovery plants have been in operation since 1967. One of the first large plants was constructed in 1972 in St. Louis, Missouri. The plant can handle 650 tons per day (TPD) of solid waste. Ferrous metals are recovered and refuse-derived fuel (RDF) is produced and fired with coal in a utility boiler. Other large resource recovery facilities have since been constructed in Ames, Iowa; Chicago, Illinois; Milwaukee, Wisconsin; New Orleans, Louisiana; Lane County, Oregon; Tacoma, Washington; and Baltimore County, Maryland.

To determine the cost-effectiveness of resource recovery facilities in Alameda County, the cost of constructing and operating facilities with capacities of 200 TPD, 800 TPD, and 3,300 TPD were estimated. This range of capacities emcompasses all anticipated facility sizes for the medium- and long-term period. Future proposals might contain facilities that are sized at a capacity in between those documented here. If that happens, appropriate cost comparisons can be made by using a linear extension of this data after adjustment for cost inflation to the future date. The cost estimates are based on recovering material from the waste stream at the recovery rates and quality given in Appendix G.

An analysis is also presented on the cost-effectiveness of labor intensive resource recovery activities which could occur at the transfer stations. The estimates of recoverable quantities of material and potential value are based on the results of activities at Sacamento and Pleasanton transfer stations.

BASIS OF DESIGN

For this type of general facility planning, it is not necessary to prepare detailed layouts and equipment lists; it is necessary only that a close approximation of the size, location, type of construction, and cost of the various facilities be developed and that this information be given in sufficient detail to permit comparisons between alternative plans. The cost estimates are based on current construction prices and the best available local market values for recovered materials. Basic design criteria for the resource recovery facility are:

- Provisions for a scale and scale house.

- Provision for public unloading area.

- Enclosure of all equipment, loading and unloading areas in a simple steel building.

- Provision for interior walls which will attenuate noise and eliminate safety problems.

- No provision for office space. (This assumes the facility is located at a transfer station.)

- Provision for small equipment maintenance facility.

- Waste composition is the same as presented in Appendix G.

- Bulk density is 25 pounds per cubic foot.

- Moisture content is 25 percent.

The construction cost estimates do not include costs for land or site-specific costs such as foundation considerations nor do they include site development costs for access roads, landscaping or fencing.

PROCESS CONFIGURATION AND COST ESTIMATES

The cost estimates for each module are presented below. The revenues from the sale of recoverable materials from each module are also presented in each cost analysis so that the cost-effectiveness of each module can be determined. Revenue credit is taken for the product of each recovery module leading up to the module for which cost-effectiveness is being set. The increment of cost and benefit for a single module can then be derived by subtracting the relevant numbers in each summary table. This information will allow an analysis of the cost-effectiveness of partial resource recovery or phased construction of resource recovery facilities. The equipment selected for each module has been chosen as the most efficient in meeting the criteria of recovery rate and quality.

The process train presented herein is designed to produce the quality of material required for the markets described in Appendix G at the selected recovery rate. Changes in technology and market factors may require changes in the process configuration.

The resource recovery facility is considered to be comprised of six individual modules known as:

- Support module (common to any combination of recovery modules).
- Reduction and ferrous recovery module.
- RDF recovery module.
- Heavy product separation module (common to the aluminum and glass recovery modules).
- Aluminum recovery module.
- Glass recovery module.

The components of each of the modules are listed below.

- The support module includes:
  - Dust collection systems.
  - Maintenance cranes and monorails.
- The reduction and ferrous recovery module includes:
  - Refuse weighing and scale house.
  - Refuse receiving and storage capacity for one day.
  - Primary shredding.
  - First-stage magnetic separation.
  - Magnetic metals concentrations system.
- The RDF recovery module includes:
  - Air classification.
  - Secondary magnetic separation.
  - Secondary shredding.
  - RDF storage and load-out.

- The heavy product separation module includes:
  - Heavy fraction screening.
  - Oversize closed-circuit shredding.

- The aluminum recovery module includes:
  - Crushing and screening.
  - Magnetic separation.
  - Eddy current separation.
  - Air-knife separation.
  - Aluminum crushing and screening.
  - Aluminum load-out.
  - Other nonferrous (ONF) load-out.
  - RDF to storage.

- The glass recovery module includes:
  - Crushing and screening.
  - Minerals jig separation.
  - Dewatering.
  - Grinding and screening.
  - Dewatering and desliming.
  - Froth flotation.
  - Filtering and drying.
  - Glass load-out.
  - ONF load-out.
  - RDF load-out.
  - Water treatment.

Process equipment for resource recovery facilities is available in sizes ranging from 25 tons per hour (TPH) to 75 TPH in 5-TPH increments. There is a range of operating hours, equipment size and number of process trains which can be used to arrive at plants with various daily capacities. The operating parameters for the three facilities estimates in this appendix are given in Table H-1.

The following discussion presents a block flow diagram of each module and discusses the unit processing equipment in each module. The capital, operating and maintenance, disposal costs, product revenues and cost/profit summary for each module are included in each module discussion.

Support Module

This module provides the environmental control and materials handling support equipment necessary for all resource recovery facilities. Costs are presented for a separate module for identification purposes only. The support module appears as a line item of cost in all five modules.

Dust Control Systems. Multiple systems are used to gather the air-laden dust from the feed conveyor pit, belt conveyor feed and discharge chute, and each pneumatic conveyor system. Little is known as to the quality of dust. The dust would be approximately 20-micron size and would contribute to the heating valve of any RDF.

Overhead Cranes and Monorails. A jib crane is located on the primary shredder feed conveyor in order to remove any large rejects before they enter the shredder. An overhead bridge crane travels over the entire processing building for maintenance purposes.

Support Module Costs. Tables H-2 through H-4 presents the costs for this module.

Reduction and Ferrous Recovery Module

Figure H-1 presents the block flow diagram for this module.

Vehicle Weigh Station. The weighing platform scales (2) are located near the facility entrance.

Receiving Building. Waste is deposited on the floor of the tipping area. Sufficient tipping area is provided for efficient operation and for storage of all solid waste likely to be received in a 24-hr period. A front-end loader is provided for each processing line.

Dumping Pit and Pan Feed Conveyors. The dumping pit consists of a concrete pit in which a horizontal metal pan conveyor is located. This conveyor feeds the primary shredder. A dust collection system, with hood located over the dumpint pit and conveyors, transports the dust to a baghouse for removal.

Primary Shredding. A hammermill shredder initially shreds the waste to a particular size of approximately three inches or less.

Table H-1. Operation Parameters for Resource Recovery Facilities

Parameters	Facility capacity		
	200 TPD	800 TPD	3,300 TPD
Number of process trains	1	2	3
Capacity of process trains, TPH	35	35	70
Daily hours of operation	6	12	16
Time reserved for maintenance, hours/day	2	4	8

Table H-2. Capital Cost for Support Module, thousands of dollars unless otherwise noted

Item	200 TPD	800 TPD	3,300 TPD
Number of processing trains	1	2	3
Capacity, tons/hour/train	35	35	70
Unit processing, conveying equipment, installed with electrical controls and foundations	415	1,230	1,665
Electrical and instrumentation[a]	42	123	167
Subtotal	457	1,353	1,832
Engineering and design at 10 percent	46	135	183
Contractors overhead and profit at 15 percent	69	203	275
Contingency at 15 percent	69	203	275
Total capital cost	641	1,894	2,565

[a]Estimated at 10 percent of unit processing equipment.

Table H-3. Annual Operating Cost for Support Module, thousands of dollars unless otherwise noted

Item	200 TPD	800 TPD	3,300 TPD
Maintenance labor[a]	32	95	128
Maintenance materials[b]	13	38	51
Utilities[c]	26	76	103
Equipment replacement and spare parts[d]	21	62	83
Total annual cost	92	271	365

[a]Estimated at 5 percent of capital cost.

[b]Estimated at 2 percent of capital cost.

[c]Estimated at 4 percent of capital cost.

[d]Estimated at 5 percent unit processing equipment installed cost.

Table H-4. Estimated (Cost) or Profit Summary for Support Modules, thousands of dollars unless otherwise noted

Item	200 TPD	800 TPD	3,300 TPD
Capital cost[a]	641	1,894	2,565
Annual capital recovery cost[b]	65	193	261
Annual operating and maintenance cost[c]	92	271	365
Financing and legal costs[d]	13	38	51
Total annual cost	170	502	677
Total cost/thruput ton, dollars	3.27	2.41	.56

[a]From Table H-2.

[b]Cost recovery factor (A/P, 8 percent, 20) = 0.1019.

[c]From Table H-3.

[d]Estimated at 2 percent of capital cost.

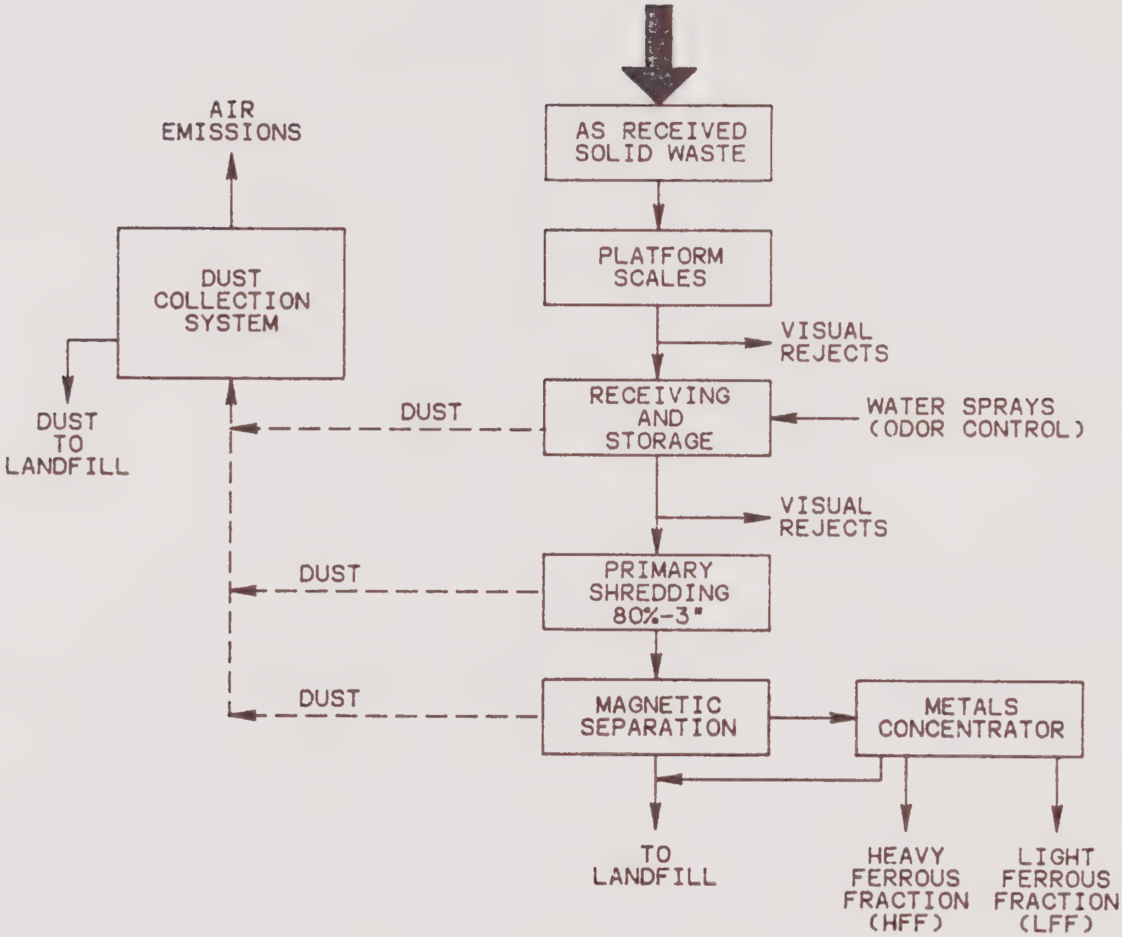


Fig. H-1 Reduction and Ferrous Recovery Module

The shredder is of sufficient size and capacity to shred oversized, bulky items such as refrigerators, hot water heaters, sofas, tires, etc., as well as normal solid waste. The shredder is enclosed by a reinforced concrete wall for both sound attenuation and for protecting personnel from possible explosions.

First Stage Magnetic Separation. A flat belt, suspended-type, magnetic separator is located over the conveyor leaving the primary shredder. A magnet removes ferrous metal from the waste stream discharged from this conveyor. Recovered ferrous metal is subsequently released and reattracted to a second magnet which results in a cleaner product, since entrapped paper is released from the magnetic stream. The ferrous metal product is then dropped onto a belt conveyor for transport to the magnetic metals cleaning system.

Magnetic Metals Cleaning System. A ferrous metals concentrator separates the stream into three fractions; the heavy ferrous fraction (HFF), light ferrous fraction (LFF) and organic fractions. The ferrous fractions are conveyed to truck roll-off containers and the balance of material is conveyed to trucks for hauling to landfill.

Reduction and Ferrous Recovery Module Costs. Tables H-5 through H-8 present the costs and revenues for this module. The shredded material has no monetary value at this point, although the benefits of shredding for landfill include less volume of material to landfill, dissipation of the odor, complete mixing of the waste stream which results in a product that will not support rodent life and could be landfilled without cover. Table H-9 shows the summary of costs for each plant as: for a 200-TPD facility, $23.26 per ton; for the 800-TPD facility, $14.63 per ton; and for the 3,300 TPD facility, $6.51 per ton.

RDF Recovery Module

The block flow diagram for this module is shown on Figure H-2.

Air Classification. The air classifier separates the light fraction (mostly paper and other organics) from the heavy fraction (glass, dirt, sticks, aluminum and nonferrous metals). The air classifier consists of a fabricated steel column with an adjustable throat through which air is drawn at a high rate. Lighter waste particles move upward with the air while the heavier pieces fall, resulting in a separation of the waste into light and heavy fractions.

The light fraction is passed through a cyclone collector to disentrain the solid particles from the air steam. The collector underflow is conveyed through a rotary valve into the secondary shredder. The classifier air is passed through a dust collector before discharge to the atmosphere. The heavy fraction drops onto a belt conveyor and is fed to a truck for landfill.

Table H-5. Capital Cost for Reduction and Ferrous Recovery Module, thousands of dollars unless otherwise noted

Item	200 TPD	800 TPD	3,000 TPD
Number of processing trains	1	2	3
Capacity, tons/hour/train	35	35	70
Unit processing, conveying equipment, installed with electrical controls and foundations	720	1,440	3,060
Buildings with foundations[a]	945	1,890	3,402
Mobilization and sitework[b]	66	132	238
Electrical and instrumentation[c]	95	144	306
Electrical substation facilities and electric lighting	100	200	400
HVAC, water, sewer and fire protection[d]	108	216	459
Vehicular equipment (front end loaders, roll off containers, tractor, pick-up)	100	153	206
Subtotal	2,134	4,175	8,071
Engineering and design at 10 percent	213	418	807
Contractors overhead and profit at 15 percent	320	626	1,210
Contingency at 15 percent	320	626	1,210
Total capital cost	2,937	5,845	11,298

[a]Estimated at $35/sq ft, land cost and unusual site conditions excluded.

[b]Estimated at 7 percent of building cost.

[c]Estimated at 10 percent of unit processing equipment.

[d]Estimated at 15 percent of unit processing equipment.

Table H-6. Annual Operating Cost for Reduction and Ferrous Recovery Module, thousands of dollars unless otherwise noted

Item	Plant capacity, tons/day		
	200	800	3,000
Administration and operating expenses	125[a]	125[a]	200[b]
Number of personnel	7	10	17.5
Administration	4	4	7.5
Operating	3	6	10
Operating labor[c]	75	150	250
Maintenance labor[d]	149	292	565
Maintenance materials[e]	60	117	226
Utilities[f]	119	234	452
Equipment replacement and spare parts[g]	36	72	153
Total annual cost	564	990	1,846

[a]Based on $25,000/year/position labor cost and $25,000/year direct cost. Costs are for a six module plant.

[b]Based on $20,000/year/position labor cost and $50,000/year/direct costs. Costs are for a six module plant.

[c]Based on $25,000/year/position.

[d]Estimated at 5 percent of capital cost.

[e]Estimated at 2 percent of capital cost.

[f]Estimated at 4 percent of capital cost.

[g]Estimated at 5 percent unit processing equipment installed cost.

Table H-7. Product Revenue for Reduction and Ferrous Recovery Module, thousands of dollars

Recovered materials	Percent in process stream[a]	Percent recovery[b]	Value, dollars/ton[c]	Annual revenue, dollars		
				200 TPD[d]	800 TPD[d]	3,300 TPD[e]
Metals						
Light ferrous fraction (LFF)	3.8	96	39	74,000	296,000	1,714,000
Heavy ferrous fraction (HFF)	1.95	96	61	59,000	238,000	1,375,000
Totals	-	-	-	133,000	534,000	3,089,000

[a]From Table G-1.

[b]Ranges given in Table G-2.

[c]From market study, Appendix G.

[d]260 days/year (5-day week).

[e]365 days/year (7-day week)

Table H-8. Residue Disposal Cost for Reduction and Ferrous Recovery Module, thousands of dollars unless otherwise noted

Percent of process stream to landfill	Plant capacity, tons/day		
	200[a]	800[b]	3,300[c]
95	245	1,373	7,037

[a]Based on 260 days/year operation, 3.75/ton disposal and 1.20/ton haul cost = 4.95/ton.

[b]Based on 260 days/year operation, 3.75/ton disposal and 3.20/ton haul cost = 6.95/ton.

[c]Based on 365 days/year operation, 3.75/ton disposal and 2.40/ton haul cost = 6.15/ton.

Table H-9. Estimated (Cost) or Profit Summary for Reduction and Ferrous Recovery Module, thousands of dollars unless otherwise noted

Item	200 TPD	800 TPD	3,300 TPD
Capital costs[a]			
Reduction and ferrous recovery module	2,987	5,845	11,298
Support module	641	1,894	2,565
Total capital cost	3,625	7,739	13,863
Annual capital recovery cost[b]	369	789	1,413
Annual operating and maintenance cost[c]			
Reduction and ferrous recovery module	564	990	1,846
Support module	92	271	365
Financing and legal costs[d]	73	155	277
Residue disposal cost[e]	245	1,373	7,037
Total annual cost	1,343	3,578	10,938
Total cost, dollars/thruput ton	25.83	17.20	9.08
Product revenue credit[f]	133	534	3,089
Product revenue credit, dollars/thruput ton	2.57	2.57	2.57
Net operating (cost) or profit[f], dollars/ton	(23.26)	(14.63)	(6.51)

[a]From Table H-5 for the reduction and ferrous recovery module and from Table H-2 for the support module.

[b]Cost recovery factor (A/P, 8 percent, 20) = 0.1019.

[c]From Table H-6 for the reduction and ferrous recovery module and from Table H-3 for the support module.

[d]Estimated at 2 percent of capital cost.

[e]From Table H-8.

[f]From Table H-7.

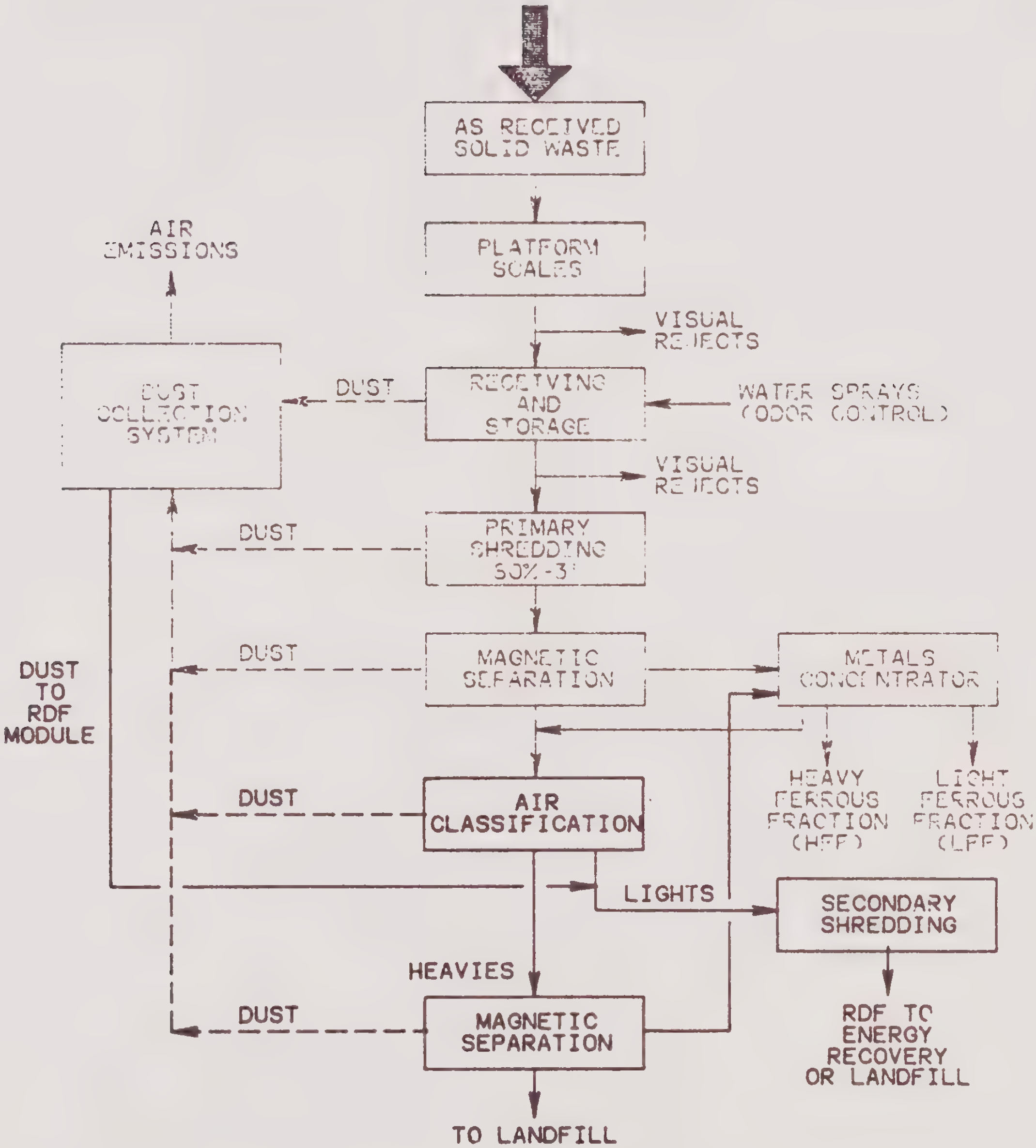


Fig. H-2 Reduction, Ferrous and RDF Recovery Module

Second-Stage Magnetic Separation. The heavy fraction from the air classifier is passed under a magnetic separator. The remaining ferrous material in the heavy fraction is separated from the waste and conveyed to the metals concentrator for further separation.

Secondary Shredder. This unit reduces the size of the RDF to that which is compatible with the particular furnace or energy recovery process. This is a horizontal swing-hammer shredder. The RDF is conveyed to a surge storage bin, for truck load-out to the energy recovery area.

RDF Recovery Module Costs. Tables H-10 through H-13 present the costs and revenues for this module. Table H-14 shows a summary of the economics for the recovery system after the addition of this module as: for a 200-TPD facility, $18.93 per ton; for the 800-TPD facility, $4.54 per ton; and for the 3,300 TPD facility, a profit of $5.89 per ton.

Heavy Product Separation Module

This module separates the heavy stream from the air classifier into two streams; a glass concentrate stream and nonferrous concentrate stream. The process flow sheet is shown on Figure H-3. This module would be used only if aluminum and glass recovery modules are to be installed or if alternate secondary materials recovery plants are located in the surrounding area which can clean up the glass and nonferrous streams. There are no revenues developed from this facility.

Heavy Fraction Screening. The heavy materials that would otherwise go to landfill are conveyed to a revolving trommel screen that separates the stream into a minus 5/8-in. glass concentrate stream and plus 5/8-in., minus 3 in. nonferrous concentrate stream.

Oversize Shredding. The oversize, 3-in. material is reduced and recycled in a closed-loop back to the trommel screen.

Heavy Product Separation Module Costs. The economics for the recovery system after the addition of this module are presented in Tables H-15 through H-17. It is noted that this facility is needed only to develop the revenues available from aluminum and glass recovery modules.

Aluminum Recovery Modules

The process flow sheet for this module is presented on Figure H-4.

Crushing, Screening and Magnetic Separation. The glass and other breakable materials in the nonferrous stream from the heavy fraction screen are crushed to about 1-1/2 in. This size reduction

Table H-10. Capital Cost for RDF Recovery Module, thousands of dollars unless otherwise noted

Item	200 TPD	800 TPD	3,300 TPD
Number of processing trains	1	2	3
Capacity, tons/hour/train	35	35	70
Unit processing, conveying equipment, installed with electrical controls and foundations	840	1,680	3,765
Buildings with foundations[a]	88	175	316
Mobilization and sitework[b]	6	12	22
Electrical and Instrumentation[c]	84	168	377
HVAC, water, sewer and fire protection[d]	126	252	565
Vehicular equipment[e]	-	-	-
Subtotal	1,144	2,287	5,045
Engineering and design at 10 percent	114	229	505
Contractors overhead and profit at 15 percent	172	343	757
Contingency at 15 percent	172	343	757
Total capital cost	1,602	3,202	7,064

[a]Estimated at $35.00/sq ft, land cost and unusual site conditions excluded.

[b]Estimated at 7 percent of building cost.

[c]Estimated at 10 percent of unit processing equipment.

[d]Estimated at 15 percent of unit processing equipment.

[e]Included in shredding and ferrous recovery module.

Table H-11. **Annual Operating Cost for RDF Recovery Module, thousands of dollars unless otherwise noted**

Item	200 TPD	800 TPD	3,300 TPD
Number of additional personnel	2	4	6
Operating labor	50	100	150
Maintenance labor[a]	80	160	353
Maintenance materials[b]	32	64	141
Utilities[c]	64	128	282
Equipment replacement and spare parts[d]	42	84	188
Total annual cost	268	536	1,114

[a]Estimated at 5 percent of capital cost.

[b]Estimated at 2 percent of capital cost.

[c]Estimated at 4 percent of capital cost.

[d]Estimated at 5 percent unit processing equipment installed cost.

Table H-12. Product Revenues for: Reduction, Ferrous and RDF Recovery Module

Recovered materials	Percent in process stream[a]	Percent recovery[b]	Value, dollars/ton[c]	Annual revenue, dollars		
				200 TPD[d]	800 TPD[d]	3,300 TPD[c]
Metals						
Light ferrous fraction (LFF)	3.8	98	39	76,000	302,000	1,749,000
Heavy ferrous fraction (HFF)	1.95	98	61	61,000	242,000	1,404,000
RDF	78.5	80	16	522,000	2,090,000	12,103,000
Totals, with a RDF market	-	-	-	659,000	2,634,000	15,256,000
Totals, assuming no revenue from RDF	-	-	-	137,000	544,000	3,153,000

[a]From Table G-1.

[b]Ranges given in Table G-2.

[c]From market study, Appendix G.

[d]260 days/year (5-day week).

[e]365 days/year (7-day week).

Table H-13. Residue Disposal Cost for Reduction, Ferrous and RDF Recovery Modules, thousands of dollars unless otherwise noted

Percent of process stream to landfill	200 TPD[c]	800 TPD[d]	3,300 TPD[e]
31[a]	80	448	2,296
95[b]	246	1,373	7,037

[a]Assuming a market for RDF is found.

[b]Assuming no market for RDF is found.

[c]Based on 260 days/year operation, 3.75/ton disposal and 1.20/ton haul cost.

[d]Based on 260 days/per year operation, 3.75/ton disposal and 3.20/ton haul cost.

[e]Based on 365 days/year operation, 3.75/ton disposal and 2.40/ton haul cost.

Table H-14. Estimated (Cost) or Profit Summary for Reduction, Ferrous and RDF Recovery Module, thousands of dollars unless otherwise noted

Item	200 TPD	800 TPD	3,300 TPD
Capital costs[a]			
Reduction and ferrous recovery module	2,987	5,845	11,298
RDF recovery module	1,602	3,202	7,064
Support module	641	1,894	2,565
Total capital cost	5,230	10,941	20,927
Annual capital recovery cost[b]	534	1,115	2,132
Annual operating and maintenance cost[c]			
Reduction and ferrous recovery module	564	990	1,846
RDF recovery module	268	536	1,114
Support module	92	271	365
Financing and legal costs[d]	105	219	419
Residue disposal cost[e,f]	80	448	2,296
Total annual cost[f]	1,643	3,579	8,172
Total cost, dollars/thruput ton[f]	31.60	17.21	6.78
Product revenue credit[f,g]	659	2,634	15,256
Product revenue credit, dollars/thruput ton	12.67	12.67	12.67
Net operating (cost) or profit[f], dollars/ton	(18.93)	(4.54)	5.89
Net operating (cost) or profit without any market for RDF, dollars/ton	(32.17)	(19.04)	(8.10)

[a]Respectively, from Tables H-10, H-5 and H-2.

[b]Cost recovery factor (A/P, 8 percent, 20) = 0.1019.

[c]Respectively, from Tables H-11, H-6 and H-3.

[d]Estimated at 2 percent of capital cost.

[e]From Table H-13.

[f]Assuming a market for RDF is available.

[g]From Table H-12.

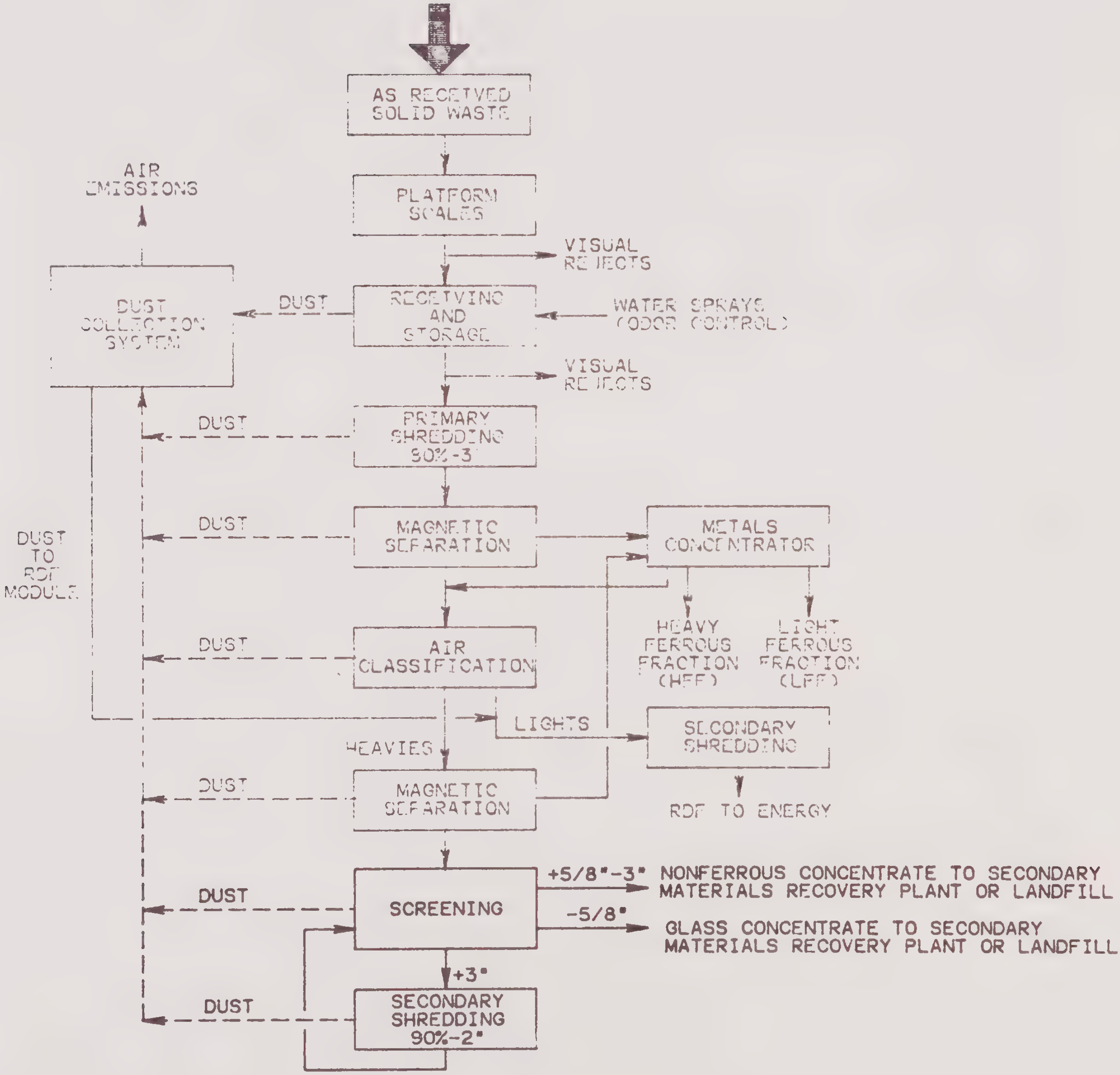


Fig. H-3 Reduction, Ferrous, RDF Recovery and Heavy Product Separation Modules

Table H-15. Capital Cost for Heavy Product Separation Module, thousands of dollars unless otherwise noted

Item	200 TPD	800 TPD	3,300 TPD
Number of processing trains	1	2	3
Capacity, tons/hour/train	35	35	70
Unit processing, conveying equipment, installed with electrical controls and foundations	270	540	1,540
Buildings with foundations[a]	88	175	316
Mobilization and sitework[b]	6	12	22
Electrical and instrumentation[c]	27	54	154
HVAC, water, sewer and fire protection[d]	41	81	231
Vehicular equipment (roll-off containers)	6	12	24
Subtotal	438	874	2,287
Engineering and design at 10 percent	44	87	229
Contractors overhead and profit at 15 percent	66	131	343
Contingency at 15 percent	66	131	343
Total capital cost	614	1,223	3,202

[a]Estimated at $35/sq ft, land cost and unusual site conditions excluded.

[b]Estimated at 7 percent of building cost.

[c]Estimated at 10 percent of unit processing equipment.

[d]Estimated at 15 percent of unit processing equipment.

Table H-16. Annual Operating Cost for the Heavy Product Separation Module, thousands of dollars unless otherwise noted

Item	200 TPD	800 TPD	3,300 TPD
Number of additional personnel	1	2	3
Operating labor	25	50	75
Maintenance labor[a]	31	61	160
Maintenance materials[b]	12	24	64
Utilities[c]	25	49	128
Equipment replacement and spare parts[d]	14	27	77
Total annual cost	107	211	504

[a]Estimated at 5 percent of capital cost.

[b]Estimated at 2 percent of capital cost.

[c]Estimated at 4 percent of capital cost.

[d]Estimated at 5 percent unit processing equipment installed cost.

Table H-17. Estimated (Cost) or Profit Summary for Reduction, Ferrous, RDF, Heavy Product and Support Modules, thousands of dollars unless otherwise noted

Item	200 TPD	800 TPD	3,300 TPD
Capital costs[a]			
Reduction and ferrous recovery module	2,987	5,845	11,298
RDF recovery module	1,602	3,202	7,064
Heavy product recovery module	614	1,223	3,202
Support module	641	1,894	2,565
Total capital cost	5,844	12,164	24,129
Annual capital recovery cost[b]	596	1,240	2,459
Annual operating and maintenance cost[c]			
Reduction and ferrous recovery module	564	990	1,846
RDF recovery module	268	536	1,114
Heavy product recovery module	107	211	504
Support module	92	271	365
Financing and legal costs[d]	117	243	483
Residue disposal cost[e,f]	80	448	2,296
Total annual cost[f]	1,824	3,939	9,067
Total cost, dollars/thruput ton[f]	35.08	18.94	7.52
Product revenue credit[g,f]	659	2,634	15,256
Product revenue credit[f], dollars/thruput ton	12.67	12.67	12.67
Net operating (cost) or profit[f], dollars/ton	(22.41)	(6.27)	5.15
Net operating (cost) or profit assuming no RDF market, dollars/ton	(35.65)	(20.77)	(8.84)

[a]Respectively, from Tables H-15, H-10, H-5, and H-2.

[b]Cost recovery factor (A/P, 8 percent, 20) = 0.1019.

[c]Respectively, from Tables H-16, H-11, H-6, and H-3.

[d]Estimated at 2 percent of capital cost.

[e]From Table H-13.

[f]Assuming a market for RDF is available.

[g]From Table H-12.

and separation provides for more efficient eddy current separation of the aluminum. The materials less than 1-1/2 in. are mixed with the glass concentrate stream. A magnetic separator removes the ferrous materials which have passed over the screen and are still in the process stream.

Eddy Current Separator. Eddy currents in the aluminum and other nonferrous stock are generated by a magnetic field in the separator. The aluminum and other nonferrous stock are removed when the magnetic field is changed by a linear motor under the conveyor belts located in the separator. The eddy current separator draws the aluminum away from the body of the trash onto a cross conveyor. The recovered materials are conveyed to a second eddy current separator to repeat the process and purify the product. The organic rejects contain a small amount of other nonferrous materials that are captured by the metals concentrator and conveyed to a roll-off truck container.

Air-Knife Separator. The aluminum and other nonferrous product stream is subjected to an air-knife separator which separates the municipal aluminum scrap (MAS) from the mixed other nonferrous scrap (ONFS) and small quantity of organics. These organics are combined with the RDF stream. The ONFS is conveyed to a truck roll-off container.

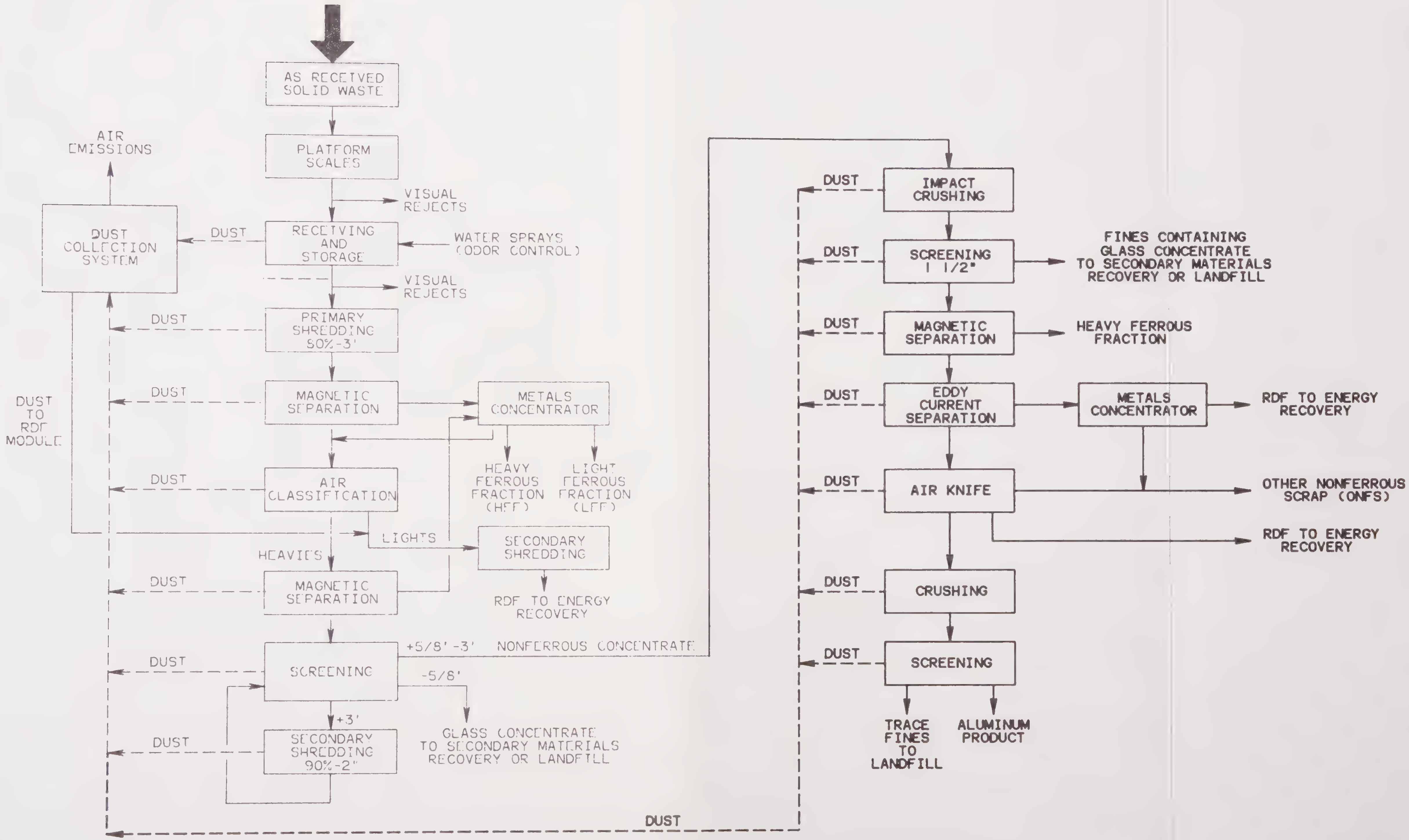
Crushing and Screening. The MAS is crushed to 1 in. in order to increase its bulk density, screened to remove any fines and conveyed to its load-out area.

Aluminum Recovery Module Costs. The economics for the aluminum recovery module are presented in Tables H-18 through H-21. Table H-22 shows a summary of the costs for the recovery system after the addition of this module. The costs per input ton for the 200-TPD, 800-TPD and 3,300 TPD facilities are $24.27, $5.48 and a profit of $7.00, respectively, assuming a market for RDF is found.

Glass Recovery Module

Technology for recovering a reusable glass product from the solid waste stream is rapidly developing. The equipment used in this process has been employed for many years in the mining industry and is used to produce the silica sand that is the raw ore used to make glass products. The block flow diagram for this module is shown on Figure H-5.

Crushing and Screening. The minus 5/8-in. stream from the heavy fraction screen and 1-1/2 in. material from the aluminum recovery module is crushed to minus 1/2 in. The plus 1/2-in.



BROWN AND CALDWELL
CONSULTING ENGINEERS
WALNUT CREEK, CALIFORNIA

Fig. H-4 Reduction, Ferrous, RDF, Heavy Product Separation and Aluminum Recovery Modules

Table H-18. Capital Cost for Aluminum Recovery Module, thousands of dollars unless otherwise noted

Item	200 TPD	800 TPD	3,300 TPD
Number of processing trains	1	2	3
Capacity, tons/hour/train	35	35	1,770
Unit processing, conveying equipment, installed with electrical controls and foundations	345	690	177
Buildings with foundations[a]	56	112	202
Mobilization and sitework[b]	4	8	14
Electrical and instrumentation[c]	35	69	173
HVAC, water, sewer and fire protection[d]	52	104	266
Vehicular equipment (roll off containers, tractor)	36	42	60
Subtotal	528	1,025	2,489
Engineering and design at 10 percent	53	103	249
Contractors overhead and profit at 15 percent	79	154	373
Contingency at 15 percent	79	154	373
Total capital cost	739	1,436	3,484

[a]Estimated at $35.00/sq ft, land cost and unusual site conditions excluded.

[b]Estimated at 7 percent of building cost.

[c]Estimated at 10 percent of unit processing equipment.

[d]Estimated at 15 percent of unit processing equipment.

Table H-19. Annual Operating Cost for Aluminum Recovery Module, thousands of dollars unless otherwise noted

Item	200 TPD	800 TPD	3,300 TPD
Number of additional personnel	2	2	4
Operating labor	50	50	100
Maintenance labor[a]	37	72	174
Maintenance materials[b]	15	29	70
Utilities[c]	30	57	139
Equipment replacement and spare parts[d]	17	35	89
Total annual cost	149	243	572

[a]Estimated at 5 percent of capital cost.
[b]Estimated at 2 percent of capital cost.
[c]Estimated at 4 percent of capital cost.
[d]Estimated at 5 percent unit processing equipment installed cost.

Table H-20. Product Revenues for: Reduction, Ferrous, RDF, Support, Heavy Product and Aluminum Recovery Modules

Recovered materials	Percent in process stream[a]	Percent recovery[b]	Value, dollars/ton[c]	Annual revenue, dollars		
				200 TPD[d]	800 TPD[d]	3,300 TPD[e]
Metals						
Light ferrous fraction (LFF)	3.8	98	39	76,000	302,000	1,749,000
Heavy ferrous fraction (HFF)	1.95	98	61	61,000	242,000	1,404,000
Municipal aluminum scrap (MAS)	0.50	49	454	58,000	231,000	1,340,000
Other nonferrous scrap (ONFS)	0.25	66	240	21,000	82,000	477,000
RDF, from air classifier	78.5	80	16	523,000	2,090,000	12,103,000
RDF, from aluminum plant	78.5	7	16	46,000	183,000	1,059,000
Totals, assuming a RDF market	-	-	-	785,000	3,130,000	18,132,000
Totals, assuming no RDF market	-	-	-	216,000	857,000	4,970,000

[a]From Table G-1.

[b]Ranges given in Table G-2.

[c]From market study, see Appendix G.

[d]260 days/year (5-day week).

[e]365 days/year (7-day week).

Table H-21. Residue Disposal Cost for Reduction, Ferrous, RDF, Support, Heavy Product, and Aluminum Recovery Modules, thousands of dollars unless otherwise noted

Percent of process stream to landfill	200 TPD[c]	800 TPD[d]	3,300 TPD[e]
26[a]	64	361	1,926
94[b]	242	1,359	6,963

[a]Assuming a market for RDF is found.

[b]Assuming no market for RDF is found.

[c]Based on 260 days/year operation, 3.75/ton disposal and 1.20/ton haul cost.

[d]Based on 260 days/year operation, 3.75/ton disposal and 3.20/ton haul cost.

[e]Based on 365 days/year operation, 3.75/ton disposal and 2.40/ton haul cost.

Table H-22. Estimated (Cost) or Profit Summary for Reduction, Ferrous, RDF, Heavy Product, Support and Aluminum Recovery Modules, thousands of dollars unless otherwise noted

Item	200 TPD	800 TPD	3,300 TPD
Capital costs[a]			
Reduction and ferrous recovery module	2,987	5,845	11,298
RDF recovery module	1,602	3,202	7,064
Heavy product recovery module	614	1,223	3,202
Aluminum recovery module	739	1,436	3,484
Support module	641	1,894	2,565
Total capital cost	6,583	13,600	27,613
Annual capital recovery cost[b]	671	1,386	2,814
Annual operating and maintenance cost[c]			
Reduction and ferrous recovery module	564	990	1,846
RDF recovery module	268	536	1,114
Heavy product recovery module	107	211	504
Aluminum recovery module	149	243	572
Support module	92	271	365
Financing and legal costs[d]	132	272	552
Residue disposal cost[e,f]	64	361	1,926
Total annual cost	2,047	4,270	9,693
Total cost, dollars/thruput ton	39.37	20.53	8.05
Product revenue credit[f,g]	785	3,130	18,132
Product revenue credit, dollars/thruput ton	15.10	15.05	15.05
Net operating (cost) or profit[f], dollars/ton	(24.27)	(5.48)	7.00
Net operating (cost) or profit assuming no RDF market, dollars/ton	(38.64)	(21.21)	(8.09)

[a]Respectively, from Tables H-18, H-15, H-10, H-5, and H-2.

[b]Cost recovery factor (A/P, 8 percent, 20) = 0.1019.

[c]Respectively, from Tables H-19, H-16, H-11, H-6, and H-3.

[d]Estimated at 2 percent of capital cost.

[e]From Table H-21.

[f]Assuming a market for RDF is available.

[g]From Table H-20.

material is recirculated back to the crusher. The crushed material ranging in size from fines up to 1/2-in. makes excellent feedstock for the minerals jig.

Minerals Jig and Dewatering Screens. Jigs have been used for many years in the minerals beneficiation industry to separate and upgrade ores. The separation is based on the differences in specific gravity of the components in the feedstock. A bed of material is allowed to build up in the basin of the jig. The heavier material, nonferrous metals and glass, work their way to the bottom of the bed while the lighter materials, mainly organics rise to the top and are floated off. The dewatering screens dewater the organic fraction making it usable as RDF and dewater the glass stream before it is sent to fine grinding. The water from the screens goes to waste treatment.

Rod Mill Grinding and Screening. The glass stream is conveyed to a rod mill where it is ground to minus 20-mesh size, suitable for froth flotation. The screened plus 1/4-in. product consisting primarily of ONFS is conveyed to the ONFS stream from the aluminum recovery module. The minus 1/4-in., plus 20-mesh material is recycled through the rod mill.

Dewatering and Froth Flotation. The minus 20-mesh glass stream is conveyed to dewatering hydrocyclones for dewatering and desliming. The slimes and minus 150-mesh material is removed from the stream and sent to water treatment.

Froth Flotation Cells. This unit removes the contaminants, mainly small cermaics and stones from the glass stream. A flotation reagent is mixed with water and injected into the cells at a controlled rate.

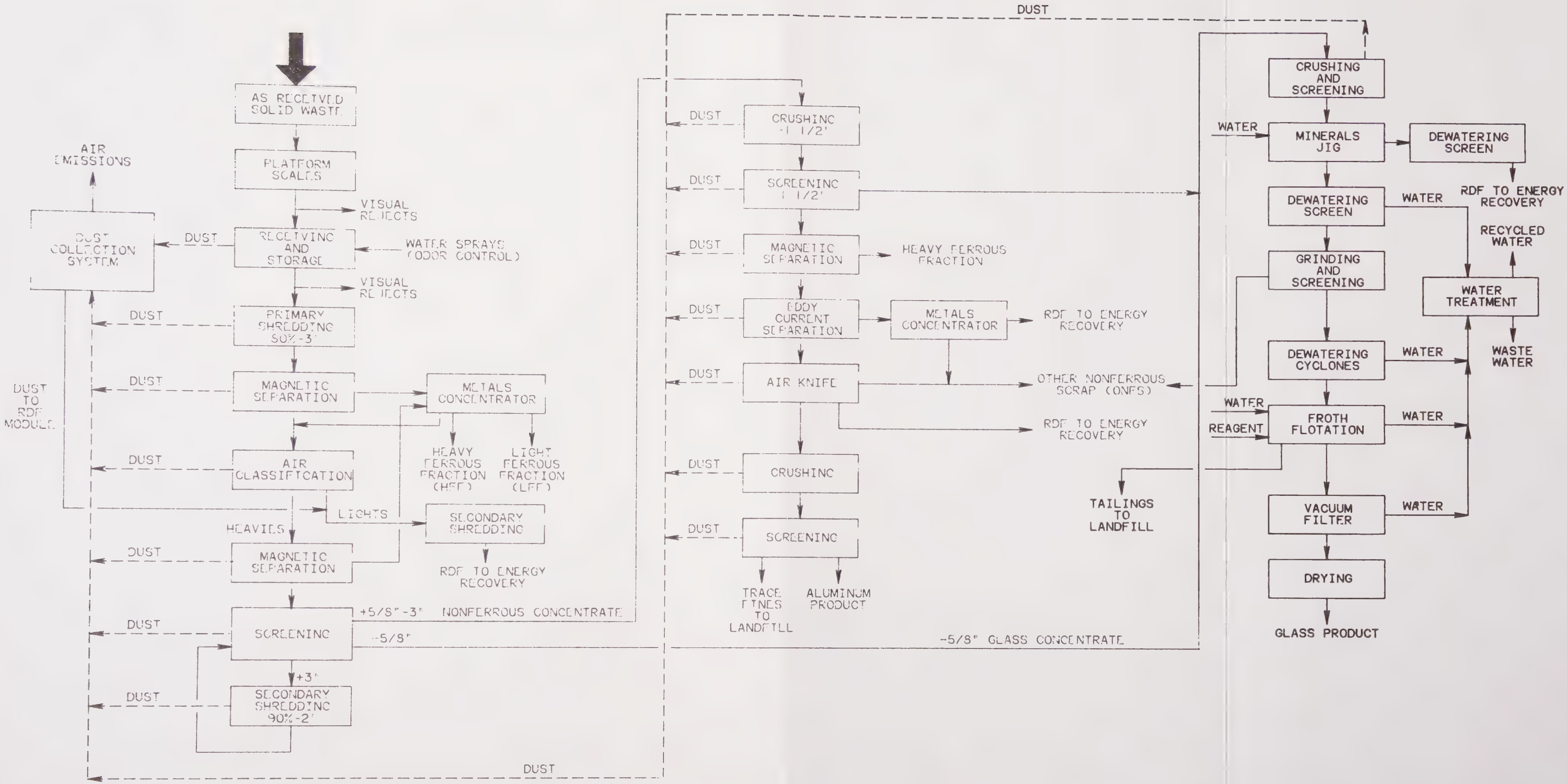
Vacuum Filtering and Drying. The froth-floated glass product is dewatered by a vacuum filter and dried. The glass is conveyed to storage bins for transfer to railroad cars or trucks.

Glass Recovery Module Costs. The economics for the glass recovery module are presented in Tables H-23 through H-26. Table H-27 shows a summary of the costs for the recovery systems after the addition of this module. The costs per input ton for the 200 TPD, 800 TPD and 3,300 TPD facilities are $27.84, $549 and a profit of $8.80, respectively, assuming a market for RDF is found.

Labor-Intensive Resource Recovery

Resource recovery operations can be undertaken at transfer stations. The analysis presented herein is predicated on the following assumptions:

- Transfer stations are designed primarily for the efficient movement of refuse from collection vehicles to long haul transfer vehicles.



BROWN AND CALDWELL
CONSULTING ENGINEERS
WALNUT CREEK, CALIFORNIA

Fig. H-5 Reduction, Ferrous, RDF, Heavy Product Separation, Aluminum and Glass Recovery Modules

Table H-23. Capital Cost for Glass Recovery Module, thousands of dollars unless otherwise noted

Item	200 TPD	800 TPD	3,300 TPD
Number of processing trains	1	2	3
Capacity, tons/hour/train	35	35	70
Unit processing, conveying equipment, installed with electrical controls and foundations	500	1,000	2,025
Buildings with foundations[a]	88	175	316
Mobilization and sitework[b]	6	12	22
Electrical and instrumentation[c]	50	100	203
HVAC, water, sewer and fire protection[d]	75	150	304
Vehicular equipment (roll-off containers, tractor)	36	42	60
Subtotal	755	1,479	2,930
Engineering and design at 10 percent	75	147	293
Contractors overhead and profit at 15 percent	113	222	440
Contingency at 15 percent	113	222	440
Total capital cost	1,056	2,076	4,103

[a]Estimated at $35.00/sq ft, land cost and unusual site conditions excluded.

[b]Estimated at 7 percent of building cost.

[c]Estimated at 10 percent of unit processing equipment cost.

[d]Estimated at 15 percent of unit processing equipment cost.

Table H-24. Annual Operating Cost for Glass Recovery Module, thousands of dollars unless otherwise noted

Item	200 TPD	800 TPD	3,300 TPD
Number of additional personnel	2	2	4
Operating labor	50	50	100
Maintenance labor[a]	53	104	205
Maintenance materials[b]	21	40	82
Utilities[c]	42	82	164
Equipment replacement and spare parts[d]	25	50	101
Total annual cost	191	326	652

[a]Estimated at 5 percent of capital cost.

[b]Estimated at 2 percent of capital cost.

[c]Estimated at 4 percent of capital cost.

[d]Estimated at 5 percent unit processing equipment installed cost.

Table H-25. Product Revenues for: Reduction, Ferrous, RDF, Support, Heavy Product, Aluminum and Glass Recovery Modules

Recovered materials	Percent in process stream[a]	Percent recovery[b]	Value, dollars/ton[c]	Annual revenue, dollars		
				200 TPD[d]	800 TPD[d]	3,300 TPD[e]
Metals						
Light ferrous fraction (LFF)	3.8	98	39	76,000	302,000	1,749,000
Heavy ferrous fraction (HFF)	1.95	98	61	61,000	242,000	1,404,000
Municipal Aluminum scrap (MAS)	0.50	49	454	58,000	231,000	1,340,000
Other nonferrous scrap (ONFS)	0.25	66	240	21,000	82,000	477,000
Glass	8.5	63	21	59,000	234,000	1,355,000
RDF (from air classifier)	78.5	80	16	523,000	2,090,000	12,103,000
RDF (from aluminum plant)	78.5	7	16	46,000	183,000	1,059,000
RDF (from glass plant)	78.5	7	16	46,000	183,000	1,059,000
Total (assuming a RDF market)	-	-	-	890,000	3,547,000	20,546,000
Total (assuming no RDF market)	-	-	-	275,000	1,091,000	6,325,000

[a]From Table G-1.

[b]Ranges given in Table G-2.

[c]From market study, see Appendix G.

[d]260 days/year (5 day week).

[e]365 days/year (7 day week).

Table H-26. Residue Disposal Cost for Reduction, Ferrous, RDF, Support, Heavy Product, Aluminum and Glass Recovery Modules, thousands of dollars unless otherwise noted

Percent of process stream to landfill	200 TPD[c]	800 TPD[d]	3,300 TPD[e]
14[a]	36	202	1,037
89[b]	229	1,287	6,593

[a]Assuming a market for RDF is found.

[b]Assuming no market for RDF is found.

[c]Based on 260 days/year operation, 3.75/ton disposal and 1.20/ton haul cost.

[d]Based on 260 days/year operation, 3.75/ton disposal and 3.20/ton haul cost.

[e]Based on 365 days/year operation, 3.75/ton disposal and 2.40/ton haul cost.

Table H-27. Estimated (Cost) or Profit Summary for all Resource Recovery Facilities, thousands of dollars unless otherwise noted

Item	200 TPD	800 TPD	3,300 TPD
Capital costs[a]			
Reduction and ferrous recovery module	2,987	5,845	11,298
RDF recovery module	1,602	3,202	7,064
Heavy product recovery module	614	1,223	3,202
Aluminum recovery module	739	1,436	3,484
Glass recovery module	1,056	2,076	4,103
Support module	641	1,894	2,565
Total capital cost	7,639	15,676	31,716
Annual capital recovery cost[b]	778	1,597	3,232
Annual operating and maintenance cost[c]			
Reduction and ferrous recovery module	564	990	1,846
RDF recovery module	268	536	1,114
Heavy product recovery module	107	211	504
Aluminum recovery module	149	243	572
Glass recovery module	191	326	652
Support module	92	271	365
Financing and legal costs[d]	153	314	634
Residue disposal cost[e]	36	202	1,037
Total annual cost	2,338	4,690	9,956
Total cost, dollars/thruput ton	44.96	22.55	8.26
Product revenue credit[f,g]	890	3,547	20,546
Product revenue credit, dollars/thruput ton	17.12	17.06	17.06
Net operating (cost) or profit[f], dollars/ton	(27.84)	(5.49)	8.80
Net operating (cost) or profit assuming no RDF market, dollars/ton	(43.38)	(22.52)	(7.62)

[a]Respectively, from Tables H-23, H-18, H-15, H-10, H-5, and H-2.

[b]Cost recovery factor (A/P, 8 percent, 20) = 0.1019.

[c]Respectively, from Tables H-24, H-19, H-16, H-11, H-6, and H-3.

[d]Estimated at 2 percent of capital cost.

[e]From Table H-26.

[f]Assuming a market for RDF is available.

[g]From Table H-25.

- There are inherent health and safety problems in sorting through compacted waste discharged from collection vehicles. Therefore, wastes collected in compactor vehicles from residential, commercial and light industrial waste sources will not be processed in any labor-intensive resource recovery projects.

- The primary waste sources available for resource recovery are wastes delivered to the station by the public and uncompacted material delivered to the transfer station in drop boxes.

- It is assumed that 20 percent of the solid waste processed through a station is available for labor-intensive resource recovery activities.

- One man can process approximately 26 tons of waste per day and approximately 10 percent of that material can be recovered. Expected composition of recovered materials is:

  - Light ferrous fraction 66 percent
  - Heavy ferrous fraction 30 percent
  - Aluminum 2 percent
  - Other mixed bulky scrap 2 percent

- Annual wage requirements are $16,000/man/year.

The quantities of waste available for sorting at the five transfer stations and the manpower requirements are presented below:

Transfer Station	Sortable Waste Quantities TPD	Manpower Requirements
North Oakland	160	7
South Oakland	120	5
Hayward	170	7
Fremont	110	4
Pleasanton	70	3
Total	630	26

Based on the assumed composition of the sortable waste stream and assuming the value of the recovered material will be 50 percent

of the value of recovered material given in Appendix G, the potential value of the recoverable material in Alameda County is given below:

	Percentage in Recovered Material	Annual Quantity, tons/yr	Unit Value, $/ton	Annual Value, millions of dollars
Light ferrous fraction	66	15,000	20	0.30
Heavy ferrous fraction	30	7,000	30	0.21
Aluminum	2	460	225	0.14
Other mixed bulky scrap	2	460	20	0.01
Total				0.66

Unit values for recovered materials are only 50 percent of those given in Appendix G. Since material contamination will occur in the vehicles delivering the waste. Also the amount of material recovered and the frequency of deliveries are not enough to justify premium market prices.

With annual wages at approximately $400,000, the labor intensive resource recovery system could earn a profit of $250,000 if the projections given above hold.

APPENDIX I

EVALUATION OF WASTE TO ENERGY CONVERSION SYSTEMS

APPENDIX I

EVALUATION OF WASTE TO ENERGY CONVERSION SYSTEMS

A large number of options for energy recovery from solid waste are available, ranging from well-proven processes such as waterwall incineration of unprocessed refuse, through the more sophisticated pyrolysis systems that often involve pretreatment of the refuse for materials recovery and production of a refuse-derived fuel (RDF). However, there are a limited number of forms into which energy can be converted, stored, transported and then utilized. This limitation reduces the options for energy recovery and results in limited opportunities for developing energy conversion facilities.

The three most feasible forms of energy for the markets identified in Appendix G are electricity, steam and fuel gas. Therefore, the evaluation of waste to energy conversion systems concentrated on systems that could produce electricity, steam and fuel gas. The evaluation has been completed in a series of steps which starts with a listing of most available system technologies and, through selective screening, was narrowed to the most viable few. The procedure is described in the following sections covering process selection criteria, process screening, process evaluation, cost factors, air pollution considerations, and ultimately, a comparison of the electricity, steam and fuel gas systems as to their cost effectiveness in Alameda County.

LIST OF ENERGY CONVERSION SYSTEMS

A search of the literature reveals a large number of energy conversion system, some of which are at an experimental stage, others which have progressed to pilot-scale and demonstration-size tests and still others which are full-scale systems treating up to 3,000 TPD of solid waste. A partial listing of available systems is presented in Table I-1. There is currently a high level of interest in thermal processing equipment that uses limited quantities of air. Commonly called pyrolysis, these systems are favored in California because of its reduced air discharges after combustion. Table I-2 is a listing of pyrolysis systems which are currently under development.

Table I-1. Energy Recovery Systems

Process and system	Energy form	Manufacturer, developer or sponsoring agency
Incineration		
Waterwall - bulk refuse	Steam or electricity	Saugus, Massachusetts
Waterwall - processed refuse	Steam or electricity	Various
Waste fired gas turbine	Steam or electricity	Combustion Power
Pyrolysis (gasification)		
Production of low Btu gas with on-site combustion (processed waste)	Steam or electricity	Various
Production of low Btu gas with on-site combustion (bulk refuse)	Steam or electricity	Andco-Torrax
Production of pyrolysis gas for off-site use	Medium Btu gas	Purox
Production of pyrolysis oil for off-site use	Pyrolysis oil	Occidental
Bioconversion		
Landfill recovery	Methane	Los Angeles County Sanitation District
Controlled landfill	Methane	REFCOM
Anaerobic digestion in reactors	Methane	Dynatech R&D

Source: Reference 1 and Brown and Caldwell.

Table I-2. Basic Type of Pyrolysis Thermal Gasification and Liquification Reactors - New, Demonstrated or Under Development

Solids flow and bed conditions	Examples of processes, developers, R&D programs	Feedstock	Main products: Fuels or char materials	Main products: Steam
Vertical-flow reactors				
Moving packed bed (gravity solids flow; also called fixed bed)	Forest Fuels Mfg., Inc.(Antrim, (N.H.)	FAR[b]	-	X
	Battelle Northwest (Richland, Wash.)	Refuse	X	X
	American Thermogen (location unknown)	Refuse	-	X
	Andco/Torrax Process (Buffalo, N.Y.)	Refuse	-	X
	H.F. Funk Process[a] (Murray Hill, N.J.)	Refuse	X	-
	Tech-Air Crop/Georgia Inst. Tech. (Atlanta, Ga.)	FAR	X	-
	Union Carbide Purox Process (Tonawanda, N.Y.)	Refuse, FAR	X	-
	Motala Pyrogas (Sweden)	Refuse	X	-
	Urban Research & Development (E. Granby, Conn.)	Refuse	X	-
	Wilwardco, Inc. (San Jose, Calif)	FAR, sludge	X	-
	U. of California (Davis, Calif)	FAR	X	-
	Foster Wheeler Power Products (London, England)	Refuse, tires	X	-
	Destrugas Process (Denmark)	Refuse	X	-
	Koppelman Process (Encino, Calif)	FAR	X	-
Moving stirred bed (gravity solids flow)	BSP/Envirotech (Belmont, Calif)	Sludge, refuse	X	X
	Nichols Research & Engr. (Belle Mead, N.J.)	Sludge, wood	X	X
	Garrett Energy Research & Engr. (Claremont, Calif)	Manure	X	-
	Hercules/Black, Crow & Eidsness (Gainesville, Fla.)	Refuse	X	-
Moving entrained bed (may include mechanical bed transport)	Occidental Petroleum Co./Garret Flash Pyrolysis Process (La Verne, Calif)	Refuse	X	-
Fluidized reactors	Copeland Systems Inc. (Oak Brook, Ill.)	Sludges	X	-
	Coors Brewing Co./U. of Missouri (Rolla, Mo.)	Refuse, FAR	X	-
	Energy Resources Co. (Erco) (Cambridge, Mass.)	Refuse, FAR	X	-
	Hercules/Black Crow & Eidsness (Gainesville, Fla.)	Refuse	X	-
	Bailie Process/Wheelabrator Incin. Inc. (Pittsburgh, Pa.)	Refuse	X	-
	A.D. Little Inc./Combustion Equipment Assoc. (Cambridge, Mass/New York, N.Y.)	Refuse	X	-

Table I-2. Basic Type of Pyrolysis Thermal Gasification and Liquification Reactors - New, Demonstrated or Under Development (continued)

Solids flow and bed conditions	Examples of processes, developers, R&D programs	Feedstock	Main products: Fuels or char materials	Main products: Steam
Horizontal and inclined flow reactors				
Tumbling solids bed	Devco Management Inc. (New York, N.Y.)	Refuse	-	X
	Monsanto Landgard/City of Baltimore, Md.	Refuse	X	X
	Watson Energy Systems (Los Angeles, Calif)	Refuse	-	X
	Ecology Recycling Unlimited, Inc. (Santa Fe Springs, Calif)	Refuse	X	-
	Pyrolenergy System/Arcalon (Amsterdam)	Refuse, FAR	X	-
	Pan American Resources, Inc. (West Covina, Calif)	Refuse, FAR	X	-
	Kobe Steel (Japan)	Tires	X	-
	JPL/Orange County, Calif. (Fountain Valley, Calif)	Sludge	X	-
	Rust Engineering (Birmingham, Ala)	Refuse, sludge	X	-
	Tosco Corp/Goodyear Tire and Rubber (Los Angeles, Calif/ Akron, Ohio)	Tires	X	-
Agitated solids bed	Deco Energy Co. (Irvine, Calif)	Tires	X	-
	Enterprise Co. (Santa Ana, Calif)	Refuse	X	-
	Kemp Reduction Corp. (Santa Barbara, Calif)	Refuse, FAR	X	-
	PyroSol (Redwood City, Calif)	Fluff from scrapped autos	-	X
Static solids bed	Thermex, Inc. (Hayward, Calif)	Tires	X	-
Molten metal or salt beds				
Floating solids bed (horizontal flow)	Michigan Tech. U. (Houghton, Mich.) (Puretec Pyrolysis System)	Refuse, FAR	X	-
Mixed molten-salt bed (various possible flow schemes)	Battelle Northwest (Richland, Wash.)	Refuse	X	-
	Anti-Pollution Systems, Inc. (Pleasantville, N.J.)	[illegible], sludge	X	-
Multiple-reactor systems				
Combined entrained-bed/static-bed reactor system	U. of California (Berkeley, Calif)	Pulping liquor	X	-
Combined moving packed-bed/entrained-bed reactor	Battelle Columbus Laboratories[a] (Columbus, Ohio)	Paper, biomass	X	-
Combined mechanically conveyed static-solids-bed/moving packed-bed reactor	Mansfield Carbon Products, Inc. (Gallatin, Tenn.)	Refuse	X	-

[a] Pressure above atmospheric.

[b] Forestry and/or agricultural residues.

Source: References 2 and 3.

PROCESS SELECTION CRITERIA

The scope of this study did not allow consideration of all the processes listed in Tables I-1 and I-2. To eliminate some of the systems, the following criteria were established for investigation and retention of the more feasible processes:

1. Processes shall have evolved beyond the experimental stage of development, and adequate information shall be readily available.
2. Manufacturers, developers, representatives and/or vendors of the process shall have a proven performance record and adequate financial backing.
3. Market for the energy product shall be readily available.
4. Adequate reduction in solid waste going to landfill shall be achieved.
5. Processes shall have been designed for large-scale operation.

PROCESS SCREENING

Two screening steps are used to select those processes for which detailed evaluations were made.

Preliminary Screening

Twelve waste-to-energy conversion systems have been retained from the lists presented in Tables I-1 and I-2. The preliminary screening used process selection criteria 1 and 2. The processes are listed in Table I-3.

Combustion of RDF as a supplemental fuel in conjunction with traditional solid (coal), liquid (oil), or gaseous (natural gas) fuels in conventional stoker beds or suspension-fired boilers has been discussed in Appendix G. The preparation of RDF is considered in Appendix G as a part of the front-end processing plant. In this chapter, only the processing of RDF in reactors for the purpose of producing fuel gas, steam or electricity is considered and subjected to screening.

Secondary Screening

The 12 systems which survived the preliminary screening were then evaluated using process selection criteria 3, 4 and 5. Six systems were retained for further evaluation, and these systems are described in the next section.

Table I-3. Energy Conversion System Remaining After Preliminary Screening

Process	Manufacturer or consultant[a]
Waterwall incineration	Various
Fluidized bed furnace	Black Clawson, various
Andco Torrax	Andco Incorporated
Purox	Union Carbide
Flash pyrolysis	Occidental Research
Multiple-hearth furnace	Various
Modular incineration	Various
CPU-400	Combustion Power
Monsanto Landgard	Monsanto Enviro-Chem Systems
X-50	Pyrolysis Systems, Inc.
Enterprise Deco	Enterprise Company
Bioconversion systems	Dynatech R/D Corporation, others

[a]See Reference for complete description of companies.

Energy recovery processes eliminated during the secondary screening stage include modular incineration, CPU-400, Monsanto Landgard, X-50, Enterprise/Deco and bioconversion systems. A brief description of each system and the reason for disregarding it from further consideration are given below.

Modular Incineration. Small-scale (less than 250 TPD) incineration of solid waste and RDF is generally done in modular, semicontinuous, refractory-lined units. Volume reduction of the waste is the primary objective, but steam for industrial use is occasionally produced using the sensible heat of the exhaust gas. Preprocessing of the as-received solid waste is minimal; large objects which might damage the stoker or furnace lining are removed before firing. Ferrous metals and other noncombustible materials could possibly be recovered from the ash. Volume reduction of the solid waste going into the incinerator is typically greater than 90 percent and weight reduction is about 70 percent.

The largest modular units have a 50-TPD capacity, and no more than five or six modules have presently been installed in any one location. Modular incineration systems have been installed at Silver Springs, Arkansas (16 TPD); Bellingham, Washington (6 modules at 12.5 TPD each); and Blytheville, Arkansas (4 modules at 12.5 TPD each).

Modular incinerator units can be designed to produce a relatively low-pressure steam, typically 100 psig, to be utilized relatively close to the plant. Large industrial steam consumers typically require pressures in excess of 100 psig. Since modular systems are primarily for relatively small-scale operations and produce primarily low-pressure steam, modular incineration is not considered a viable option for recovering energy from the county's solid waste. Process selection criteria 3 and 5 are not met.

CPU-400. The CPU-400, or "incinerator turbine" system, involves incineration of RDF in a fluidized sandbed at a high pressure, removal of fly ash entrained in the combustion gases using cyclones and granular filters, expansion of the gas through gas turbine electric generators, recovery of heat from the turbine exhaust in a waste heat boiler, and discharge of the gas to the atmosphere without further treatment.

Although the CPU-400 system has undergone a relatively long period of development, cleanup of the fluid bed combustion off-gas has not yet been adequate to eliminate aluminum deposits on the system turbine blades. According to Combustion Power, testing of the process has been suspended and no additional testing is scheduled. This process was thus removed from further consideration. Process selection criteria 5 is not met.

Monsanto Landgard System. Monsanto Enviro-Chem Systems, Inc., has developed a pyrolysis process which involves combustion of part of the shredded refuse feed in a rotary kiln to furnish the endothermic heat of pyrolysis required for gasification of the remaining organic material in another part of the rotary kiln. The low Btu pyrolysis gas is consumed in an afterburner; heat is recovered in a waste heat boiler. Magnetic metal and char can be recovered from the noncombustible residues. Although the Landgard process was successfully tested in a 1-TPD pilot plant at the Monsanto Research Corporation in Dayton, Ohio, in 1968 and 1969, and a 35-TPD prototype plant in St. Louis County, Missouri, from 1969 to 1971, the process has not had a successful operating history as a 1,000 TPD system in Baltimore, Maryland. Major problems such as failure of refractories in the rotary kiln and inadequacy of the air pollution control equipment have required the shutdown of the system. Recently, Monsanto decided to abandon the process. All process selection criteria are met, but since the fate of the process is uncertain, it was dropped from further consideration for this study.

X-50. The X-50 system, developed by Pyrolysis Systems, Inc., involves pyrolysis of shredded and air-classified refuse in a horizontal bed reactor operating under a slight vacuum and 1,700 F. The temperature is maintained by combusting a portion of the product gas in radiant tube heaters in the reactor. A 2-TPD pilot plant has been operated in Santa Ana, California, and a 24-TPD demonstration plant is under design for the City of Riverside, California.

The X-50 system was eliminated from further consideration due to lack of sufficient information which would allow an adequate evaluation. As results of the demonstration plant become available, a proper evaluation of the system can be undertaken. Process selection criteria 5 is not met.

Enterprise/Deco. The Enterprise/Deco system involves pyrolysis in a jacketed, horizontal cylinder equipped with an auger. Operating conditions are a slight vacuum and temperatures range from 1,000 F to 1,100 F. Energy is recovered in the form of a high Btu fuel gas, 400 Btu/sdcf, and a medium weight fuel oil. The temperature is maintained by burning the product char/ash or the product gas and passing the flue gases through the incinerator jacket.

A demonstration plant rated at 50 TPD is being tested at a Los Angeles Sanitation District facility. To date, however, insufficient information is available for adequate evaluation of the system, and therefore the Deco process is eliminated from further consideration. As results of the demonstration plant become available, a proper evaluation of the system can be undertaken. Process selection criteria 5 is not met.

Bioconversion Systems. For this study, bioconversion systems are considered to be processes which involve biological reactions that convert refuse into methane. Two type of systems have been examined, landfill gasifiers and biological reactors. The former is considered developmental as it is being studied in several prototype operations, while the latter is still in the experimental stage.

Several California landfill operators are collecting the methane produced from natural anaerobic decomposition of landfill wastes. The process occurs in deep landfills constructed with impermeable bottoms and perforated well casings for collection of gas. Gas production from landfills, however, is generally difficult to control due to the heterogeneous nature of the fill, which results in less than optimum conditions for bacterial activity. Actions necessary to increase gas production rates, such as water and nutrient additions to the waste as it is landfilled, will likely increase leachate problems. This process was dropped from further consideration for this study because it did not meet process selection criteria 3 and 4.

Reactor-based gasification involves the controlled introduction of RDF and sewage sludge into heated, mixed anaerobic digesters. RefCOM (Refuse Conversion to Methane) is a process originally developed by Dynatech R/D Corporation that is now being tested by Waste Management, Inc. in Pompano Beach, Florida. In the codigestion of RDF and raw sewage sludge, bacteria are used to convert organics in the sludge and RDF to a fuel gas with a heat value of 500 to 700 Btu/sdcf.

Codigestion has not been demonstrated beyond a bench-scale level. A 100-TPD demonstration facility is being built at Pompano Beach, Florida, under an ERDA grant by Waste Management, Inc., but will not undergo testing until 1978. Reactor gasification of mixed municipal refuse will not be considered further in this study, since this process did not meet process selection criteria 4. Reactor gasification should be reevaluated when additional information becomes available.

PROCESS EVALUATION

Six processes for energy recovery remain after the secondary screening. Each of these systems is described below, and simplified flow sheets are presented. For comparison, all systems are shown with electricity generation using condensing steam turbines, although some of the processes were originally developed to produce other end products.

Waterwall Incineration

Large-scale incineration of solid waste with the attendant recovery of energy as steam with waste heat boilers has been practiced in Europe and North America for over 50 years. A flow sheet for the process is shown on Figure I-1. Solid waste is fed directly to the furnace grate area with minimal or no preprocessing. Hydrocarbon components in the solid waste are combusted to form mostly carbon dioxide and water. The combustion reaction produces high temperature for steam recovery and destroys odor-causing compounds in the waste. The furnace walls are lined with finned, water-carrying tubes for the dual purpose of heat recovery and reduction of wall temperatures. Ash, metals, and other residues that pass through the combustion zone are water-quenched and landfilled, with possible ferrous metal recovery prior to disposal. The as-received solid waste is reduced up to 80 percent by weight and 95 percent by volume with waterwall incineration.

The steam from refuse combustion is used to power plant equipment, generate electrical power for sale, and/or provide energy for heating and cooling. A sophisticated air pollution control facility, usually including electrostatic precipitators, is needed to meet air quality standards.

There are over 100 waterwall incinerators with capacities up to 2,600 TPD in operation around the world. System configuration is governed by local conditions, including the quantity and quality of solid waste, the proximity of the plant to population centers, and the relative value of different types of energy outputs.

Waterwall furnaces are also being designed to burn coarsely shredded solid waste. The waste is fed into the furnace by spreader stokers which propel the waste across the combustion chamber, where it lands on a traveling grate. This type of firing is often referred to as semisuspension firing because the waste is ignited while it is falling through the chamber, but combustion is completed while the waste rests on the grate. The cost of shredding the waste must be balanced against the benefits obtained from a more uniform fuel and therefore, a more controllable incineration operation. Removal of ferrous metals after shredding also helps by homogenizing the fuel. A semisuspension fired waterwall incinerator is being constructed by the Black Clawson Company at Hempstead, New York, to burn wet-pulped fuel.

Although semisuspension and suspension firing systems have been developed generally for co-firing solid waste with other conventional fuels, incinerator technology has reached the stage where firing of solid waste alone in these types of systems should not present any serious obstacles.

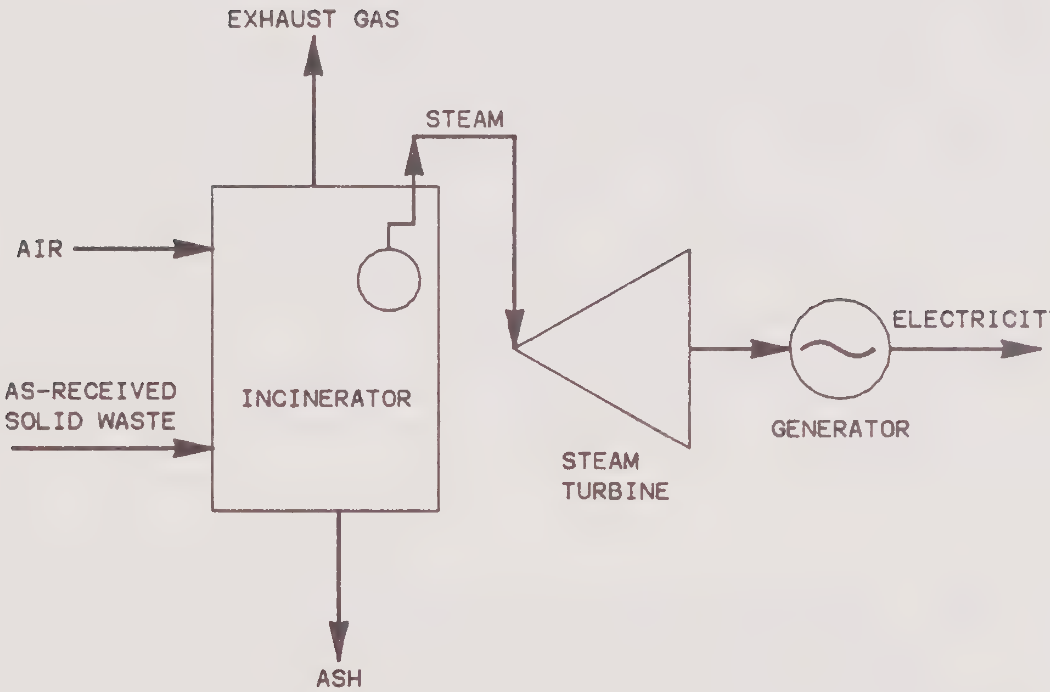


Fig. I-1 Waterwall Incineration Flowsheet

Fluidized Bed Incinerators

Incineration of solid waste or RDF in fluid bed incinerators has not been practiced on any sizable scale. However, municipal solid waste and sewage sludge have been co-incinerated in a fluid bed furnace in Franklin, Ohio, since 1971, which began as an EPA-supported resource recovery demonstration project. In this process, developed by Black Clawson Corporation, a wet pulper removes ferrous metal and heavy solids from 150 tons per day of shredded refuse. Fiber is recovered from the pulper effluent by selective screening and elutriation, and all unrecovered residuals are conveyed to a barrel thickener. Sludge from a 2.5-mgd secondary treatment plant is added to the thickened residuals, and the combined stream is dewatered in a cone press to a solids content of 45 percent before injection into the furnace. There is a buildup in bed volume with this co-incineration scheme, and a small amount of bed material must be periodically removed from the furnace. The preparation steps reduce the amount of noncombustible material in the furnace feed to between three and six percent. A process flow diagram is shown on Figure I-2.

In a normal dry shredding and separation operation, the feed stock would not be as uniform as it is at Franklin, Ohio. If the feed to the fluid bed furnace is not uniform in both size and density, material will tend to sift downward through the bed. This material must be removed quickly or it could upset the air flow through the bed.

Andco-Torrax

This process, developed by the Carborundum Company and Andco Incorporated (Buffalo, New York) involves the direct pyrolysis of unprocessed solid waste in a high temperature slagging reactor (gasifier) to produce a fuel gas with a heat content of 100 to 130 Btu/sdcf. The Torrax flow scheme is shown on Figure I-3.

As-received solid waste, with bulky items larger than about three feet in diameter removed, is introduced into the top of a vertical shaft furnace. Heat for pyrolyzing and drying the refuse and slagging the inert fraction results from combustion of carbon char with 1,600 F preheated air injected into the base. As the refuse descends in the gasifier, it is dried by rising hot gases drawn up through the furnace by induced draft. In the mid-furnace pyrolysis zone, the refuse is pyrolyzed into combustible gas and carbon char residue. In the lowest part of the furnace, the char is combusted and the refuse inerts are melted into slag. The slag is continuously drained and subsequently quenched to produce a sterile, granulated residue.

The pyrolysis gas produced is drawn off the gasifier at the top of the drying zone and separated from entrained char in a cyclonic

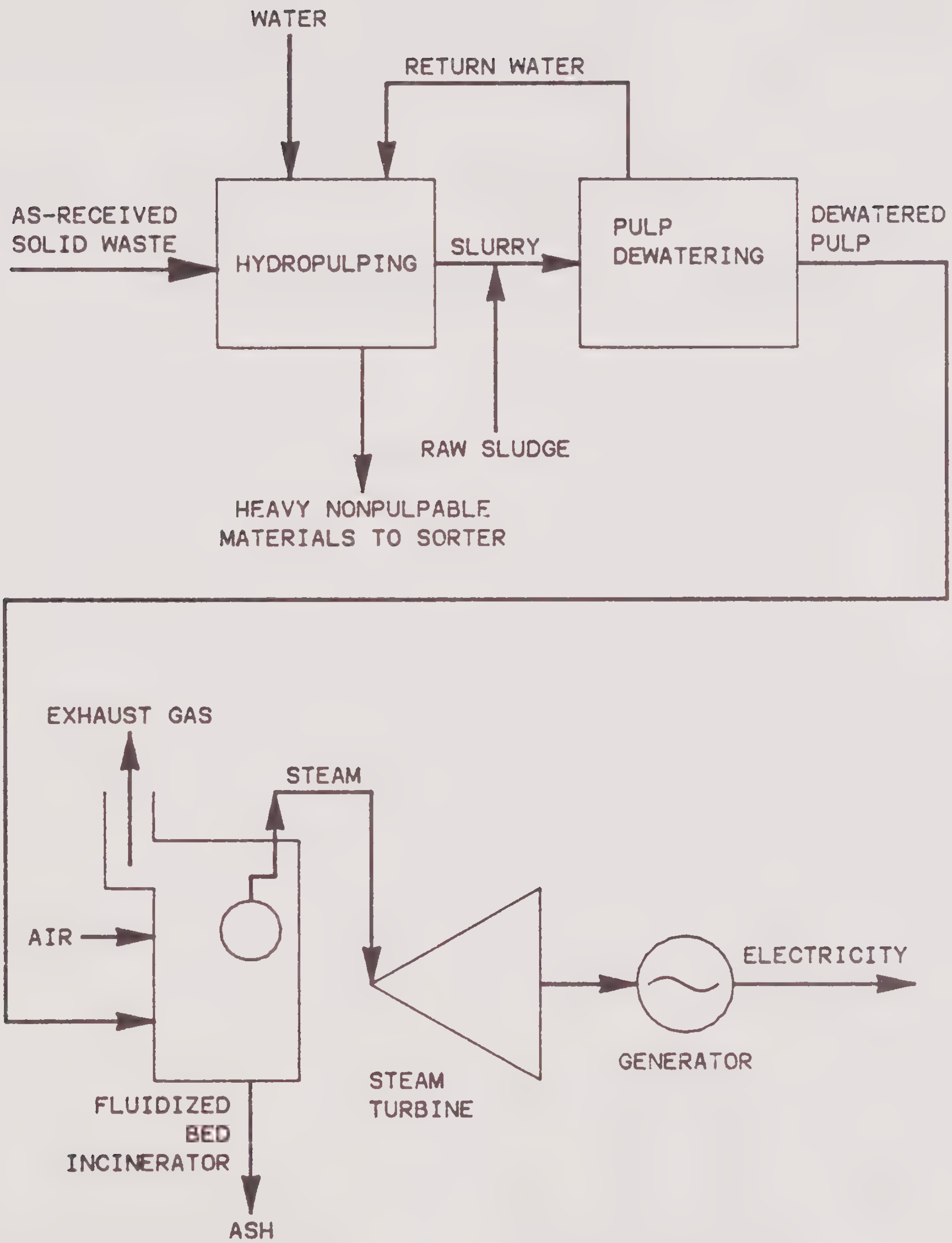


Fig. I-2 Black Clawson Fluidized Bed Process Flowsheet

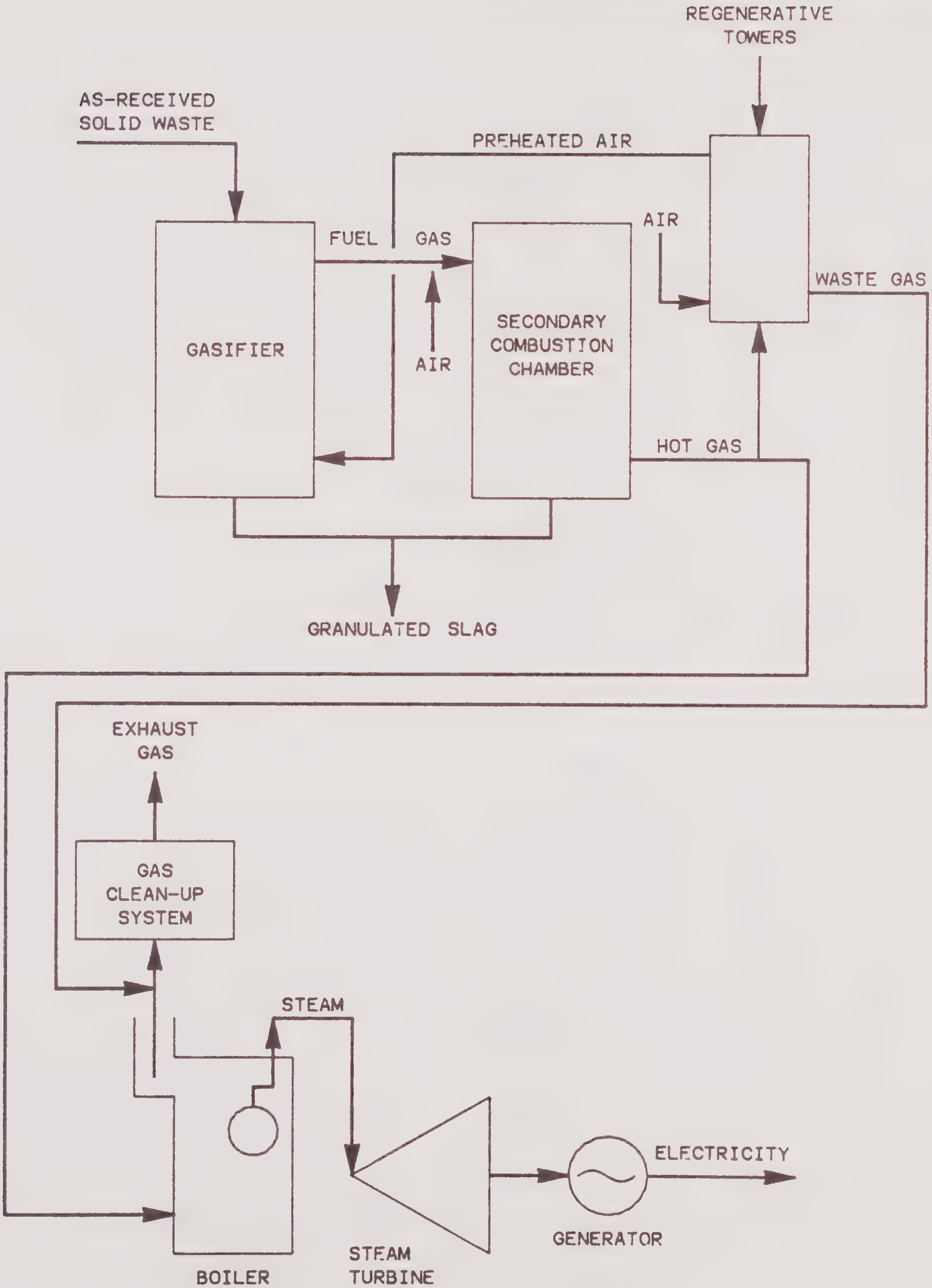


Fig. I-3 Andco-Torrax Process Flowsheet

separator. The gas is then combusted in a refractory-lined combustion chamber and, in the preferred energy recovery system, the hot off-gases (2,200-2,300 F) are passed through a scrubber followed by an electrostatic precipitator. Approximately 15 percent of the gasifier off-gas is used to preheat the combustion air; the balance, about 45,000 sdcf per ton of solid waste received, is available for energy recovery.

A 75-TPD demonstration facility was operated in Orchard Park, New York, from 1971 to 1973. All product gas was burned on site for steam generation; supplemental natural gas was used to preheat process air. Facilities at Luxembourg (200 TPD); Grasse, France (170 TPD); and Frankfurt, Germany, are under construction.

Purox Process

This process, developed by the Union Carbide Corporation, involves partial pyrolysis of shredded solid waste to produce a fuel gas with a heat value of 300 to 400 Btu per sdcf. The process flow sheet is shown on Figure I-4.

As-received solid waste is shredded to a minus 6-in. size and ferrous metal is recovered magnetically. The processed waste is then fed intermittently to the top of a vertical shaft furnace. Pure oxygen, 0.2 tons per ton of solid waste, is injected into the furnace where it effects combustion of carbon char residue to produce a temperature of about 3,000 F. Molten slag is formed in the furnace bottom and continuously overflows the combustion zone hearth into a water quench tank, where it forms a hard, sterile residue. The slag accounts for ten percent by weight and three percent by volume of the as-received solid waste. In the oxygen-starved atmosphere above the combustion zone, organic materials are pyrolyzed into carbon char and a gaseous mixture. The char moves downward in the furnace while the gases rise, drying the entering solid waste.

Pyrolysis gas from the reactor is passed through a wet scrubber and then through an electrostatic precipitator and stripped of ash and a condensable oil fraction, which are recycled to the furnace. The gas is then passed through a condenser for reduction of moisture content and can be used as a medium Btu gas or to generate electricity either with gas turbines or by just producing steam and then condensing it in a steam turbine. Wastewater discharged from the condenser is estimated at 100 gal per ton of solid waste with a five-day biochemical oxygen demand (BOD_5) of 35,000 mg/l. About 24,000 sdcf of gas are produced from one ton of solid waste.

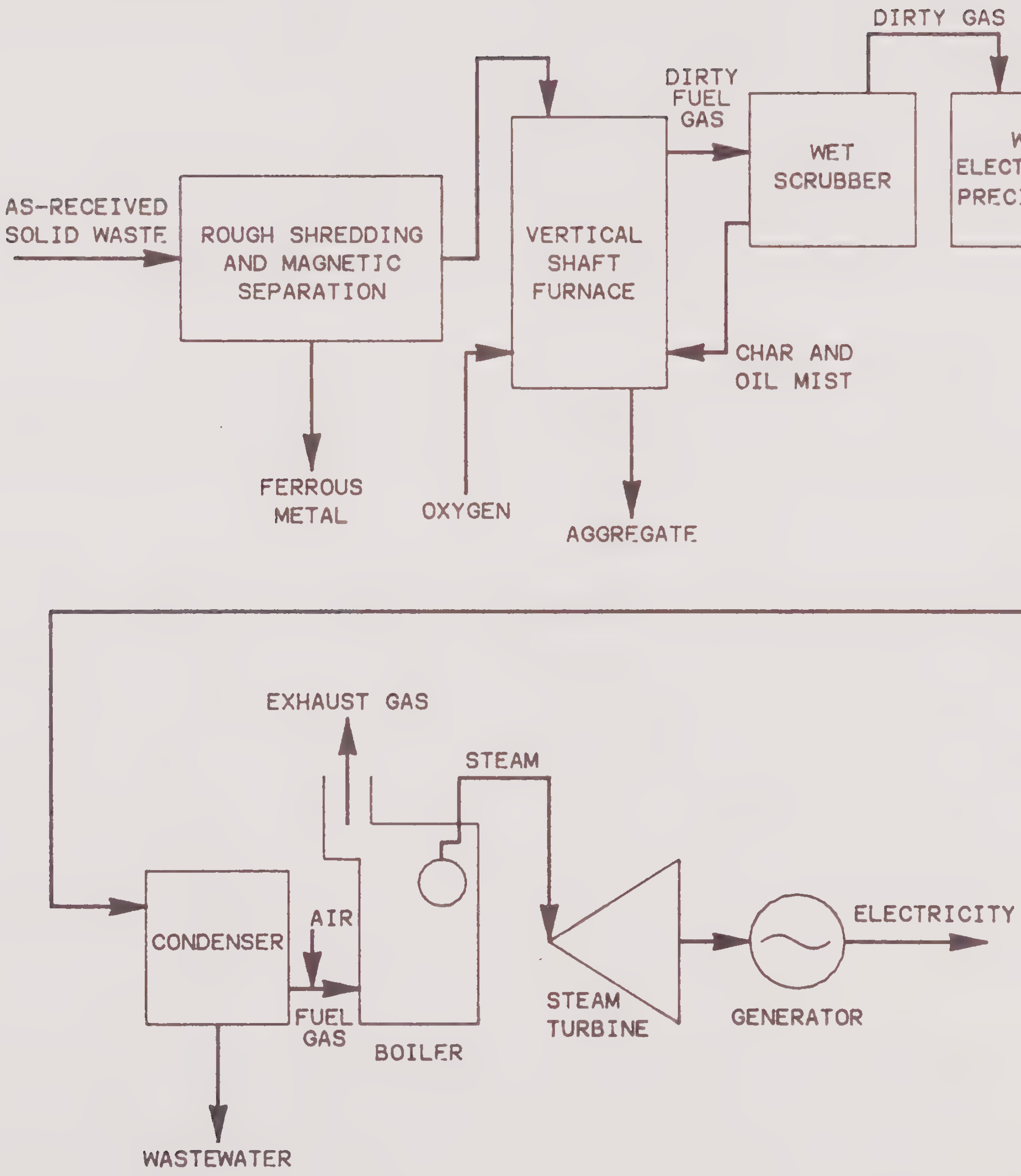


Fig. I-4 Purox Process Flowsheet

Although Purox has not yet installed a large-scale facility, a 200 TPD full-scale demonstration plant has been undergoing comprehensive testing in South Charleston, West Virginia, since early 1974.

Flash Pyrolysis

This process, developed by Occidental Research Corporation, converts fine, dried RDF into a heavy fuel oil (about 100,000 Btu per gal). The process flow sheet is shown on Figure I-5. As-received solid waste is coarse shredded and air classified into heavy and light fractions. Ferrous metal, nonferrous metal and purified ground glass are removed from the heavy fraction. The light fraction is kiln-dried, screened, finely shredded, and fed with hot pyrolysis char to a pyrolysis reactor. Oil (one barrel is produced per ton of solid waste fed) is condensed from the pyrolysis reactor off-gas. Pyrolysis char recovered in a kiln off-gas separator is recycled to the reactor to provide process heat. The oil produced in the process is highly viscous and mildly corrosive. The system also produces approximately 120 gal of wastewater per ton of solid waste. Aproximately 27 percent of this wastewater is discharged from the process condenser with a chemical oxygen demand (COD) of about 100,000 mg/l. The remainder is discharged from the glass recovery system with negligible COD and odor. A 200-TPD demonstration facility is undergoing start-up testing at El Cajon, California.

Pyrolysis in a Multiple-Hearth Furnace

In this process, RDF is combusted and pyrolyzed in a multiple-hearth furnace (MHF) to produce a low Btu fuel gas, 100 to 200 Btu per sdcf, and a coal-like char. The process flow sheet is shown on Figure I-6.

Part of the RDF is combusted to provide heat for pyrolysis. By controlling furnace air addition, the rest of the RDF is pyrolyzed to form a fuel gas and char as the solids are passed across the hearths and down through the furnace. The fuel gas is combusted in an afterburner and the off-gases are subsequently passed through a waste heat boiler to produce steam for process use and/or electrical power generation.

A 5-TPH system was tested for the Central Contra Costa Sanitary District in May and June of 1976 to gather data for design of a mixed sewage sludge and RDF co-pyrolysis system. Design is expected to start on a 600-TPD facility for the district in 1978.

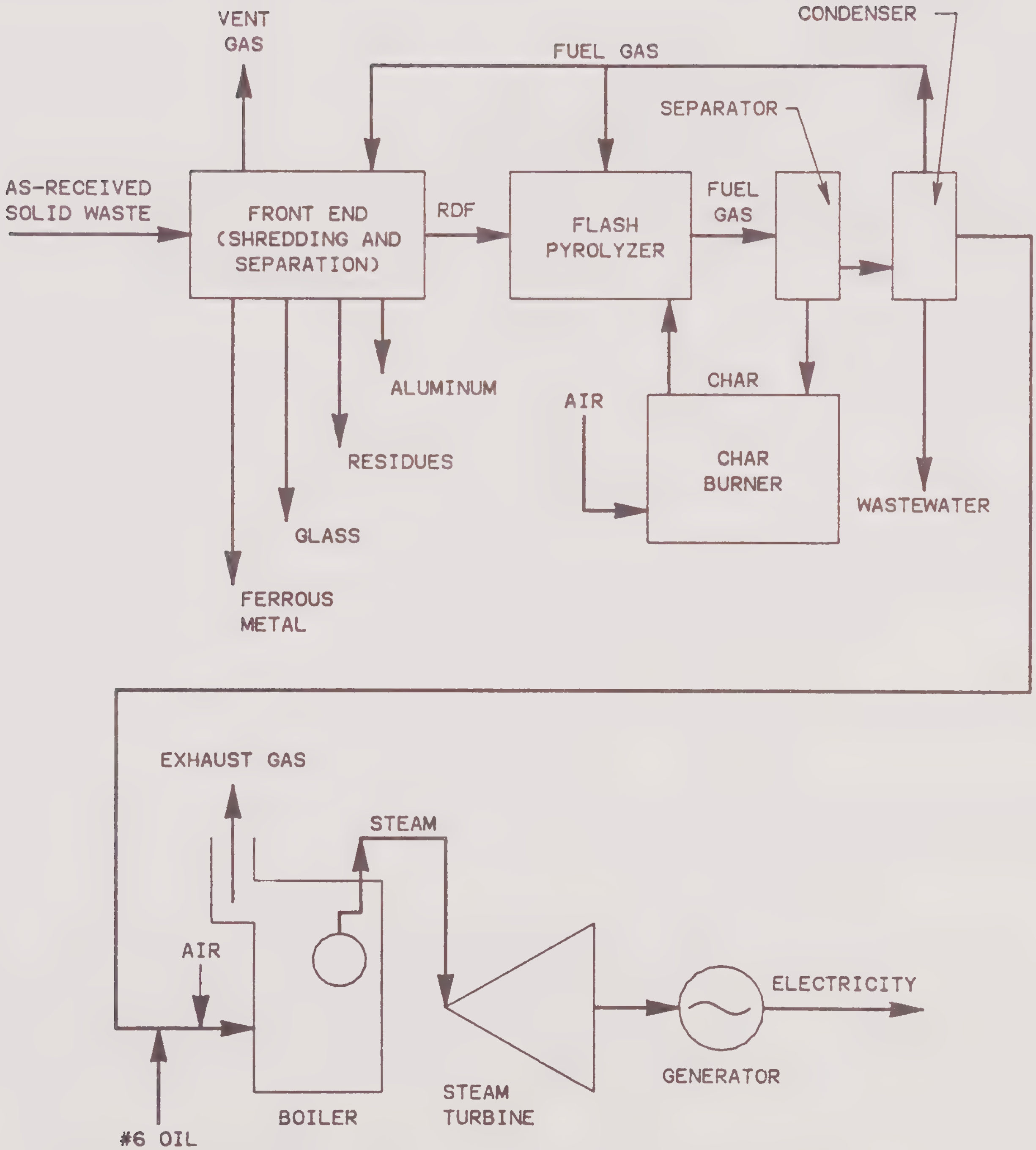


Fig. I-5 Flash Pyrolysis Process Flowsheet

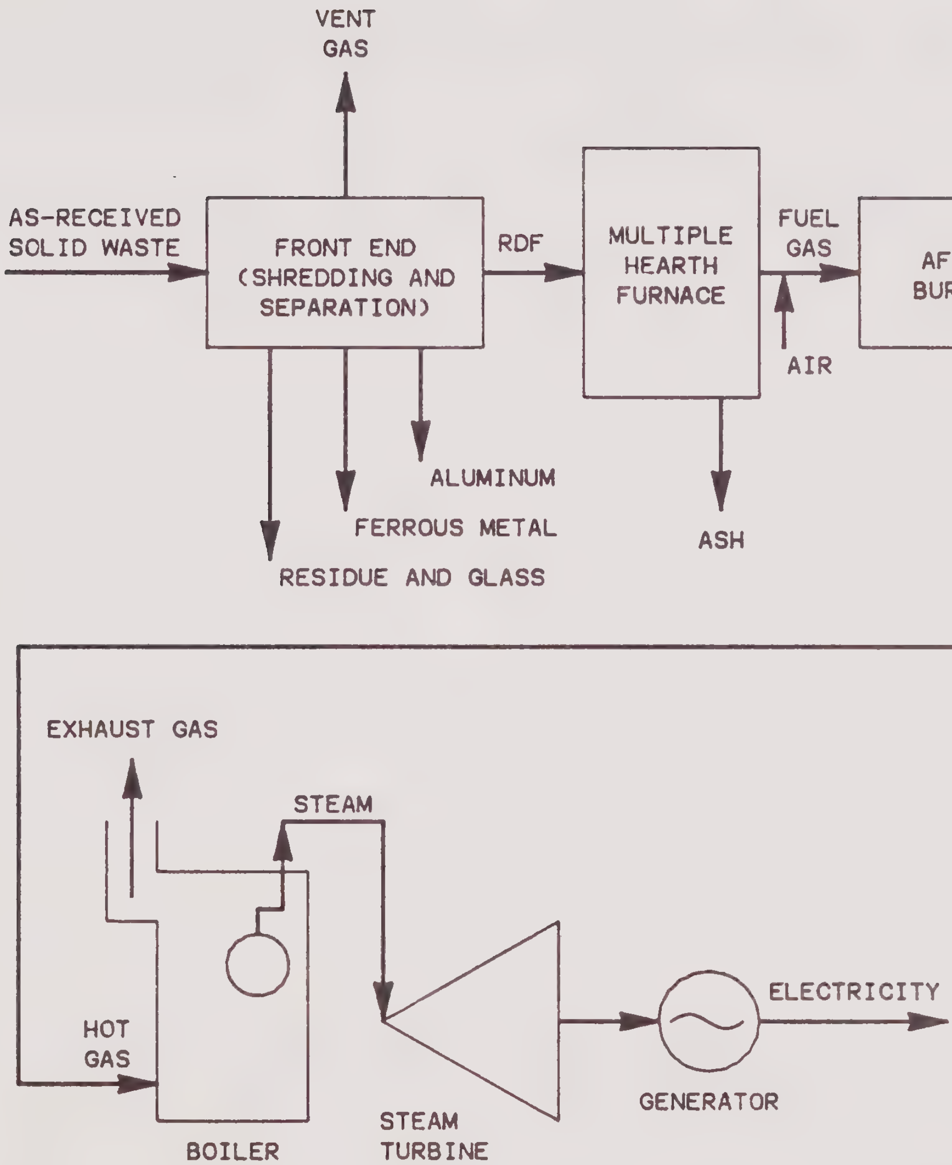


Fig. I-6 Flowsheet of Pyrolysis in a Multiple-Hearth Furnace

COST FACTORS

In the preceeding section, six types of energy conversion processes were presented as feasible energy conversion processes. This section presents capital and annual costs for four of the systems: waterwall incineration, Purox, Andco-Torrax, and multiple-hearth furnace pyrolysis.

The flash pyrolysis system is still under study, and meaningful cost factors could not be identified. The pyrolytic oil product may not be suitable for commercial use as problems may arise with oil transportation and storage because of its high viscosity, thermal sensitivity, degradation characteristic, and corrosiveness. Thus, it is likely that the oil would have to be used at the solid waste processing site for either steam production or electricity generation. Available data for the process reveal that its capital and operating costs are similar to the Andco-Torrax and Purox processes, and that exclusion of the process from the cost estimation will not significantly affect the cost ranges developed in this section.

The cost information available on the fluidized bed processes indicates that the capital costs of fluidized bed furnaces are slightly lower than multiple-hearth furnaces, and operating costs are comparable. Therefore, the fluidized bed process estimates will not significantly affect the cost ranges developed in this section, and the single presentation of costs for multiple-hearth furnaces is sufficient.

Cost Development Criteria

Capital and annual costs for the four selected energy conversion systems were determined, based on data contained in available literature and communications with vendors. The costs for systems which produce each energy form (electricity, steam and fuel gas) have been generalized and are presented in cost curves which reflect the range of cost data which have been reported. All costs are based on an Engineering News-Record Cost Construction Index (ENR-CCI) of 3100, which corresponds to December 1977. The costs include only the energy recovery system. Material preparation has been excluded from the cost data, although allowance has been made for storage. It has been assumed that the energy recovery plant will operate continuously and that material will be conveyed to the plant site on a 16-hr-a-day, 7-day-a-week basis. Final disposal of solid residues are also not included (solids disposal is considered in Appendix G.)

It has been assumed in developing the cost curve for electricity that electricity generation will be achieved using condensing steam turbines. Only one of the processes selected, Purox,

produces a pyrolytic gas sufficiently rich to be marketed and produced as a fuel gas and thus, the cost curve for gas production reflects published information on costs of the Purox system only. The cost curve for steam is based on steam production carried out in waste heat boilers which recover the heat either from combustion of pyrolysis gases or from waterwall incineration.

For comparison purposes, it has been assumed that the energy content of the raw solid waste is 4,500 Btu/lb. The heat value of the RDF is 6,000 Btu/lb and the energy conversion efficiency is the same for all processes. Although there will be differences in the energy and material balances between the systems, the discrepancies will not significantly affect the cost curves presented here. Other assumptions made in computing the energy outputs of the four systems are:

- Each pound of RDF yields 2.7 lb of 1,400 Btu/lb steam. This is a steam generating efficiency of 62 percent.
- Each pound of steam produces 0.10 kWhr of electricity. This is an electricity generating efficiency from steam of 24 percent.
- Each pound of RDF therefore has a maximum yield of 0.27 kWhr of electricity (540 kWhr/ton). This is an overall energy conversion efficiency of 5.3 percent.
- Each pound of RDF processed by the Purox system produces 3,900 Btu of Syngas. This is a conversion efficiency of 65 percent. If utilized for electricity by combustion in boilers to produce steam for power generation, it would yield 2.2 lb steam or 0.24 kWhr for an overall conversion efficiency of 13.6 percent.
- Internal process power consumptions are as follows: Purox, 160 kWhr/ton; Andco-Torrax, 125 kWhr/ton; multiple-hearth furnace, 32 kWhr/ton; and waterwall incineration, 70 kWhr/ton.

Based on information available in the literature and some discussions with system representatives, it appears for the four systems under consideration that the minimum economical plant size is 600 TPD. Maximum plant size considered in this study is 2,000 TPD, primarily because of the lack of sufficient cost data for plants in excess of 2,000 TPD.

Electricity Generation Costs

The capital costs for energy recovery facilities producing electricity are presented on Figure I-7. The mid-range cost of a

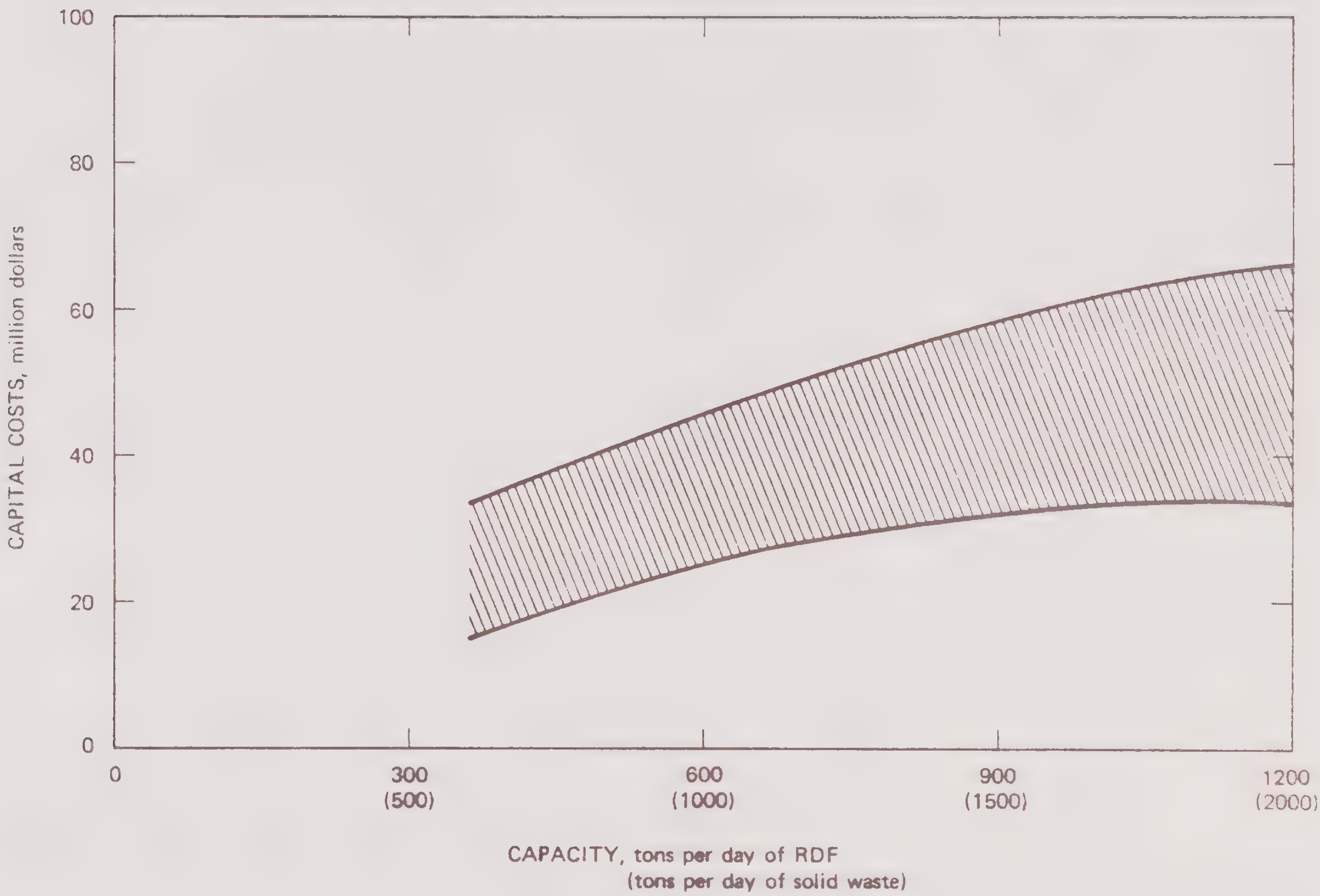


Fig. I-7 Capital Costs of Electricity Producing Energy Recovery Facilities (ENR 3100)

1,000-TPD plant is about $42 million, rising to about $63 million for a 2,000-TPD plant. Actual capital costs can be expected to vary by about ± 30 percent, depending on the process selected.

The estimated annual costs for operation (excluding electric power) and maintenance costs of electricity producing systems are shown in the upper curve of Figure I-8. The lower curve on Figure I-8 shows the cost that would be incurred if the electric power required for the process were purchased from a utility, at an assumed $0.03/kWhr. In reality, however, the power requirement will probably be met by the generation of power on-site, and these costs will not be incurred.

The annual costs, including amortization at 8 percent and 20 years, are shown on a unit basis on Figure I-9. Average figures indicate that for a 1,000-TPD facility, the O&M costs (excluding power) will be about $9.50/ton, amortization will amount to some $11.50/ton, totaling about $21.00/ton. The net operating costs, excluding electric power, can be expected to vary by about ± 20 percent for the average or mid-range value shown on Figure I-9, depending on the process finally selected.

The cost of producing exportable electric power, or power in excess of the requirements of the energy recovery plant, is shown on Figure I-10. For smaller plants, the estimated cost per kWhr varies between about 5 and 8 cents. With higher throughput facilities, production costs vary between 3 and 6 cents/kWhr. It is cautioned that these costs do not include any costs for material preparation or final disposal of solid residues.

<u>Steam Generation Costs</u>

Capital costs for energy recovery facilities producing steam are presented on Figure I-11. The mid-range cost for a 1,000-TPD plant is about $36 million, rising to about $50 million for a 2,000-TPD plant. Costs will vary by about ± 30 percent depending on the process selected.

Operation and maintenance costs are shown on Figure I-12. Annual costs, including amortization at 8 percent and 20 years, are shown on a unit basis on Figure I-13. Mid-range values for a 1,000-TPD plant are $2.50/ton for power, $7.00/ton for O&M, $9.00/ ton for amortization, and $20/ton total operating costs. Unit cost for a 2,000-TPD plant will be about 20 percent lower. Net operating costs, excluding power costs, can be expected to vary by about ± 25 percent from mid-range values, depending on the process selected.

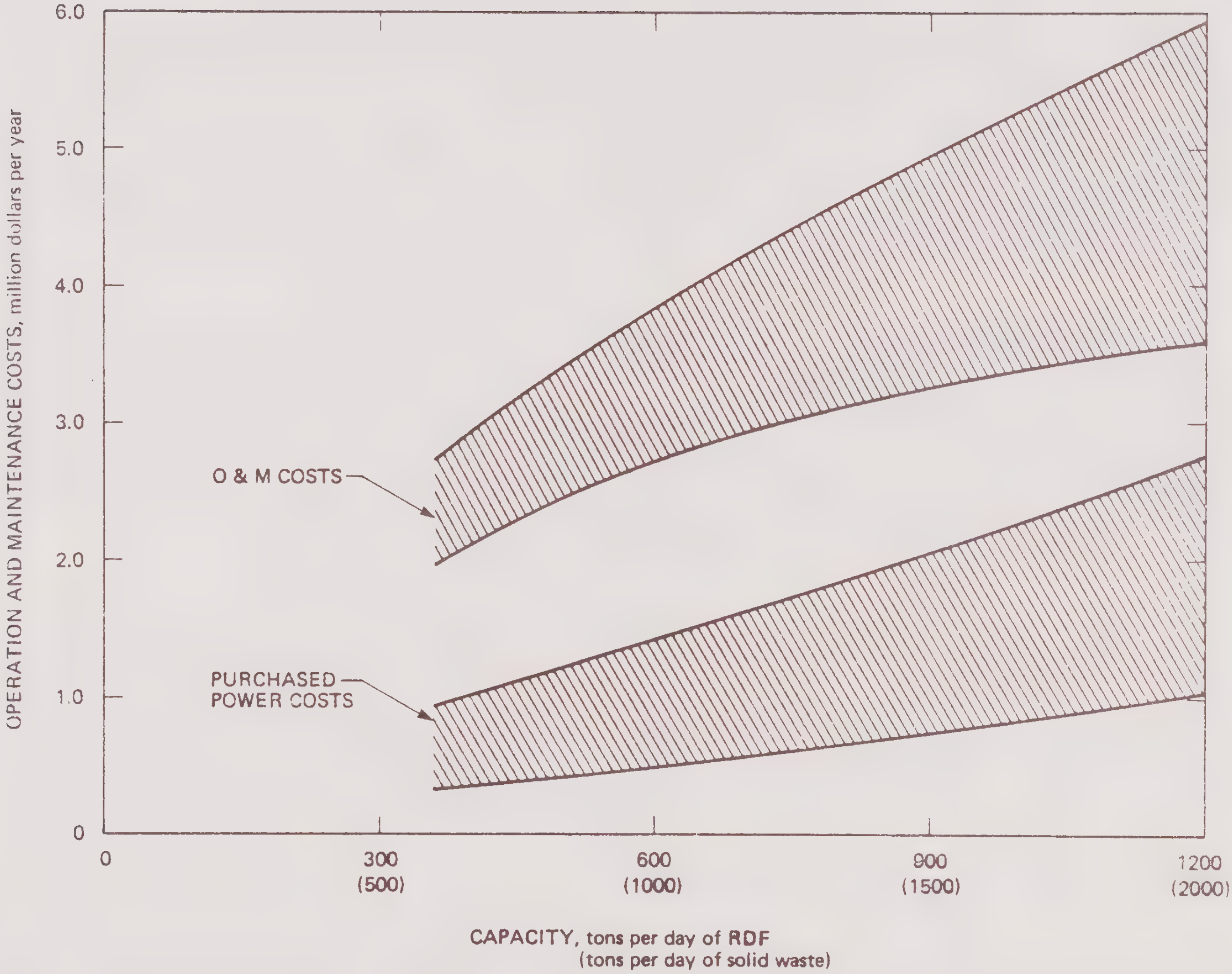


Fig. I-8 Operation and Maintenance Costs of Electricity Producing Energy Recovery System

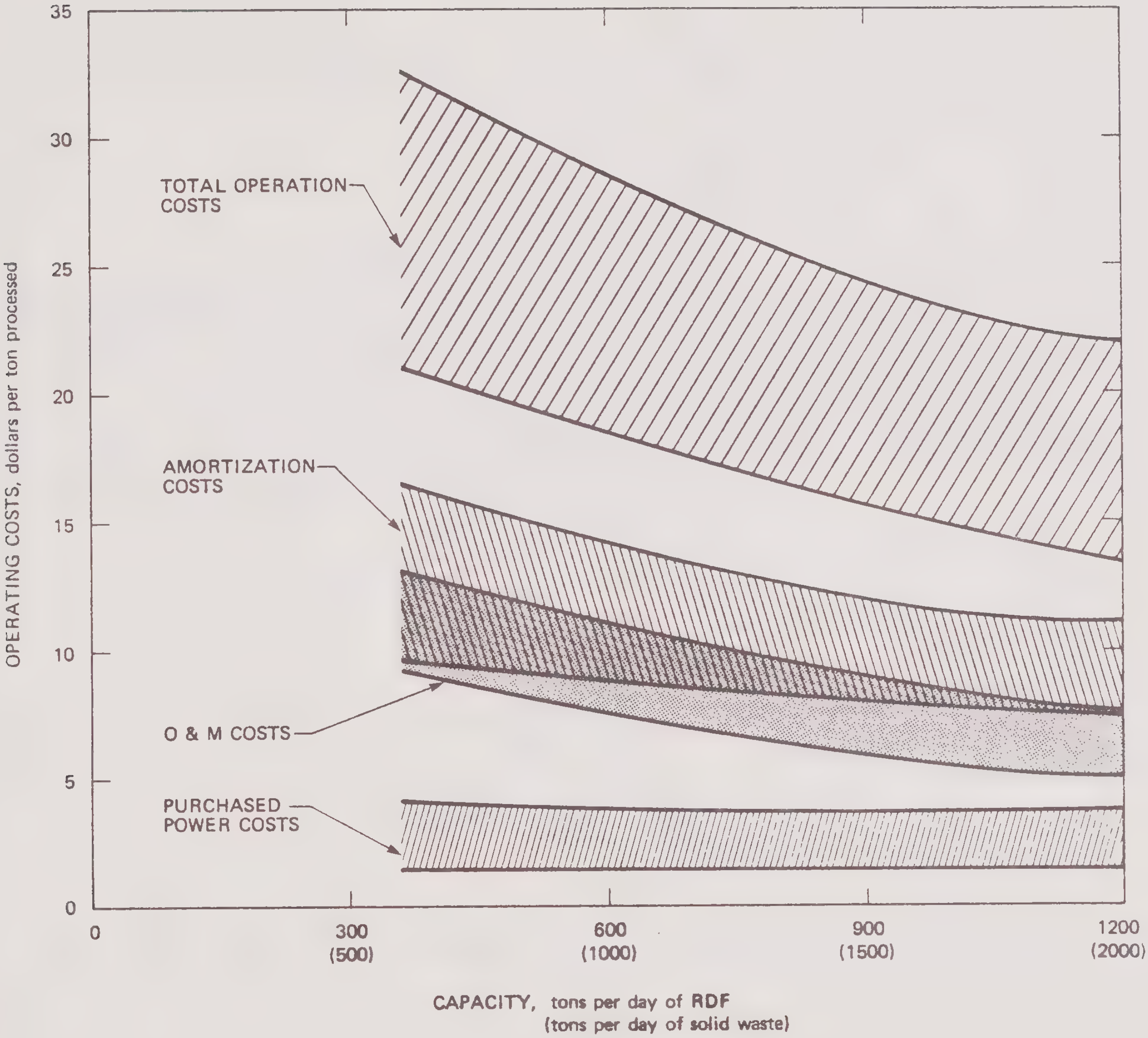


Fig. I-9 Unit Costs of Electricity Producing Energy Recovery System

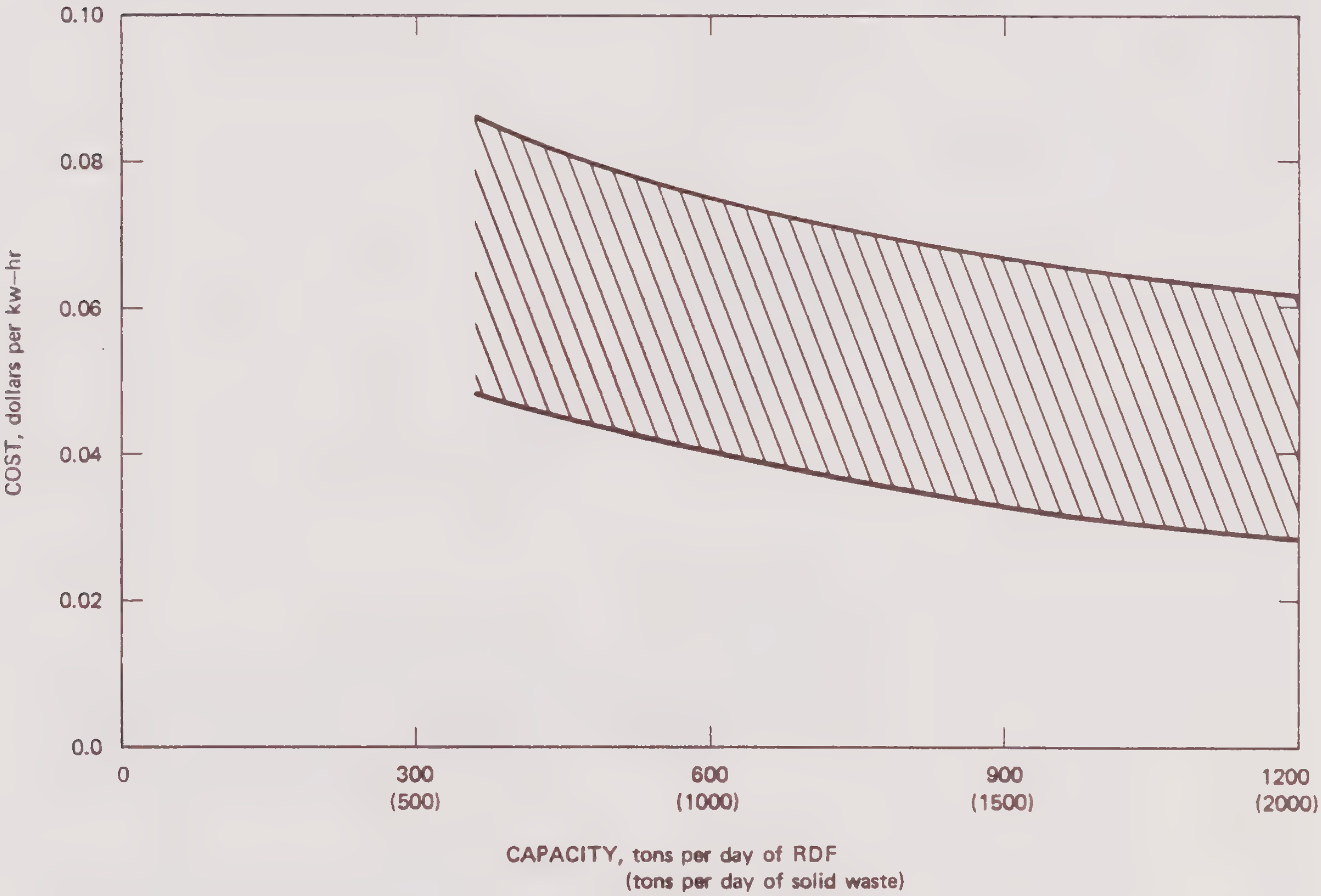


Fig. I-10 Cost of Electricity Production in Energy Recovery System

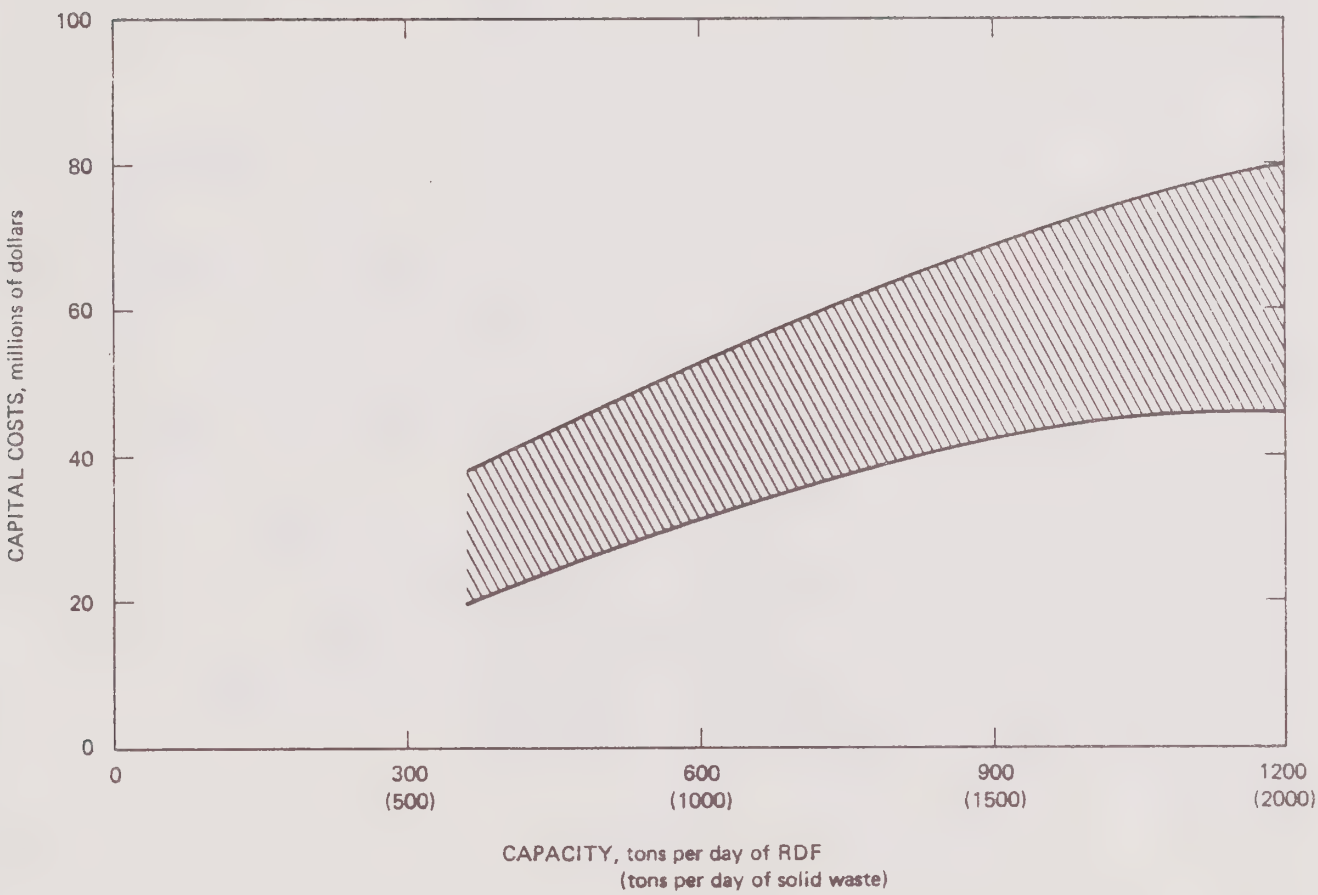


Fig. I-11 Capital Costs of Steam Producing Energy Recovery System (ENR 3100)

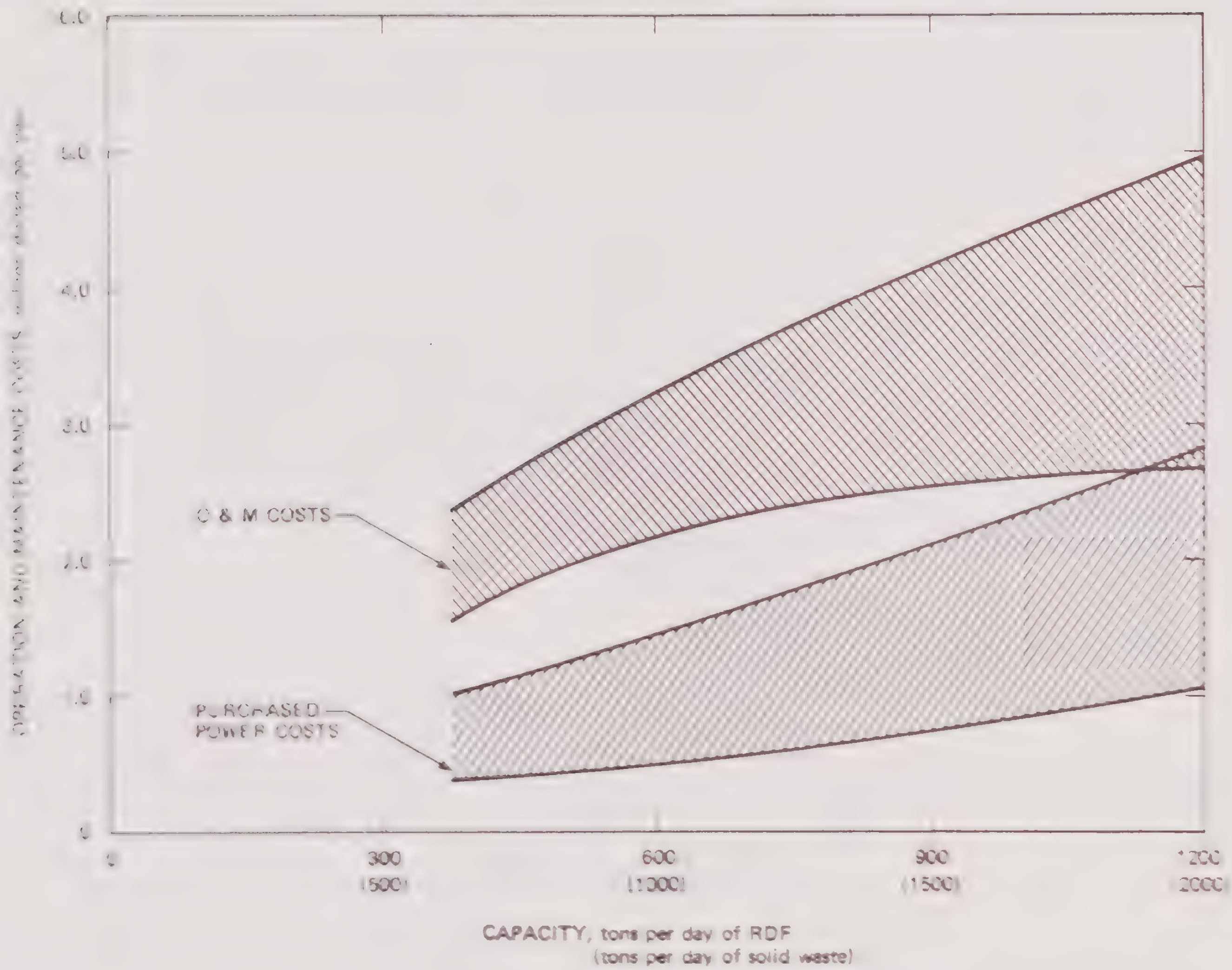


Fig. I-12 Operation and Maintenance Costs of Steam Producing Energy Recovery System

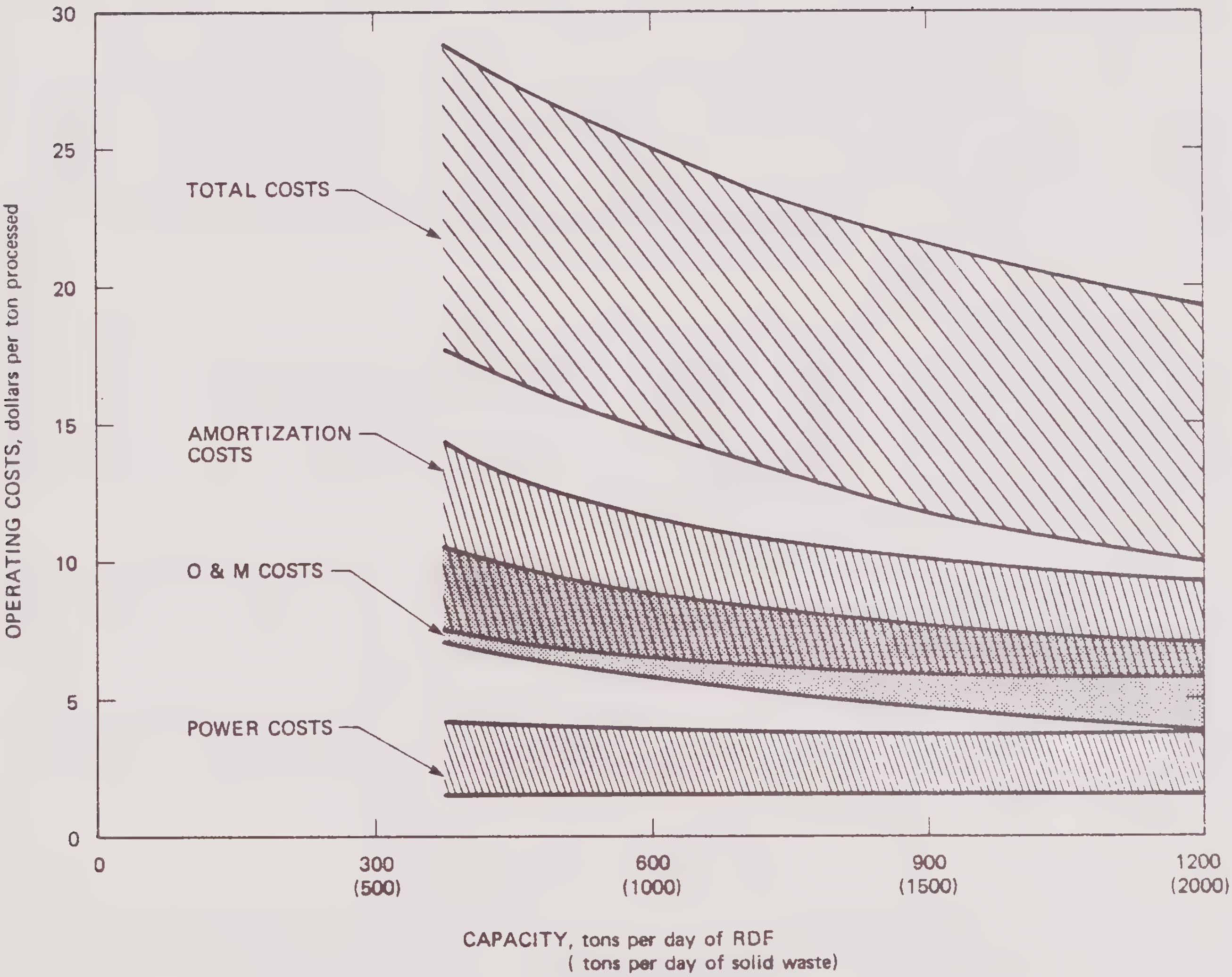


Fig. I-13 Unit Costs of Steam Producing Energy Recovery System

The cost of producing steam is shown on Figure I-14. For smaller plants, the estimated cost per 1,000 lb of steam with a heat content of 1,400 Btu varies between $4 and $7. With higher throughput facilities, production costs vary between $2.50 and $4.50 per 1,000 lb of steam.

These costs do not include any transportation or distribution costs. Without identifying potential customers and a probable energy recovery plant site, these costs cannot be determined. As an approximate estimate, the total costs for production, transportation or distribution of steam are expected to be 30 percent higher than those for production alone.

<u>Gas Generation Costs</u>

The capital costs of Purox facilities, excluding material preparation and recovery systems, are presented in Figure I-15, and annual O&M and power costs are shown on Figures I-16 and I-17. The total unit cost for production of fuel gas is shown on Figure I-18. Unit costs vary from $3.20/MM Btu for smaller plants to $2.60/MM Btu for a 2,000-TPD facility.

These costs are somewhat misleading, since they do not include any allowance for gas compression, transportation and distribution. Gas compression equipment is estimated to cost about $600/hp. Based on discussions with representatives of PGandE, it is estimated that pipeline costs could amount to $1 million per mile excluding the distribution pipework. As a very aproximate estimate, the costs for producing and distributing medium Btu gas could be almost 30 percent higher then those for gas production only, amounting to a total cost of about $3.40/MM Btu for a 2,000-TPD facility.

Cost of producing pipeline quality gas, with a Btu content higher then 900 Btu/sdcf, are uncertain. Many factors must be taken into account when determining these costs, including Purox gas quality, customer quality requirements, location of existing gas mains, compression requirements, mixing requirements, and many others. As an approximate estimate, the unit costs for upgrading the gas to pipeline quality could be double those for production alone of Purox gas, or about $5.20/MM Btu. This high cost results in part because of the assumed 65 percent efficiency of the gas upgrading process, which means that only 65 MM Btu will be obtained as 900 Btu/sdcf gas from 100 MM Btu of 350 Btu/sdcf Purox gas after methanation.

AIR POLLUTION CONSIDERATIONS

In any combustion system, air emissions are a major concern and may be the most difficult regulations to satisfy when siting

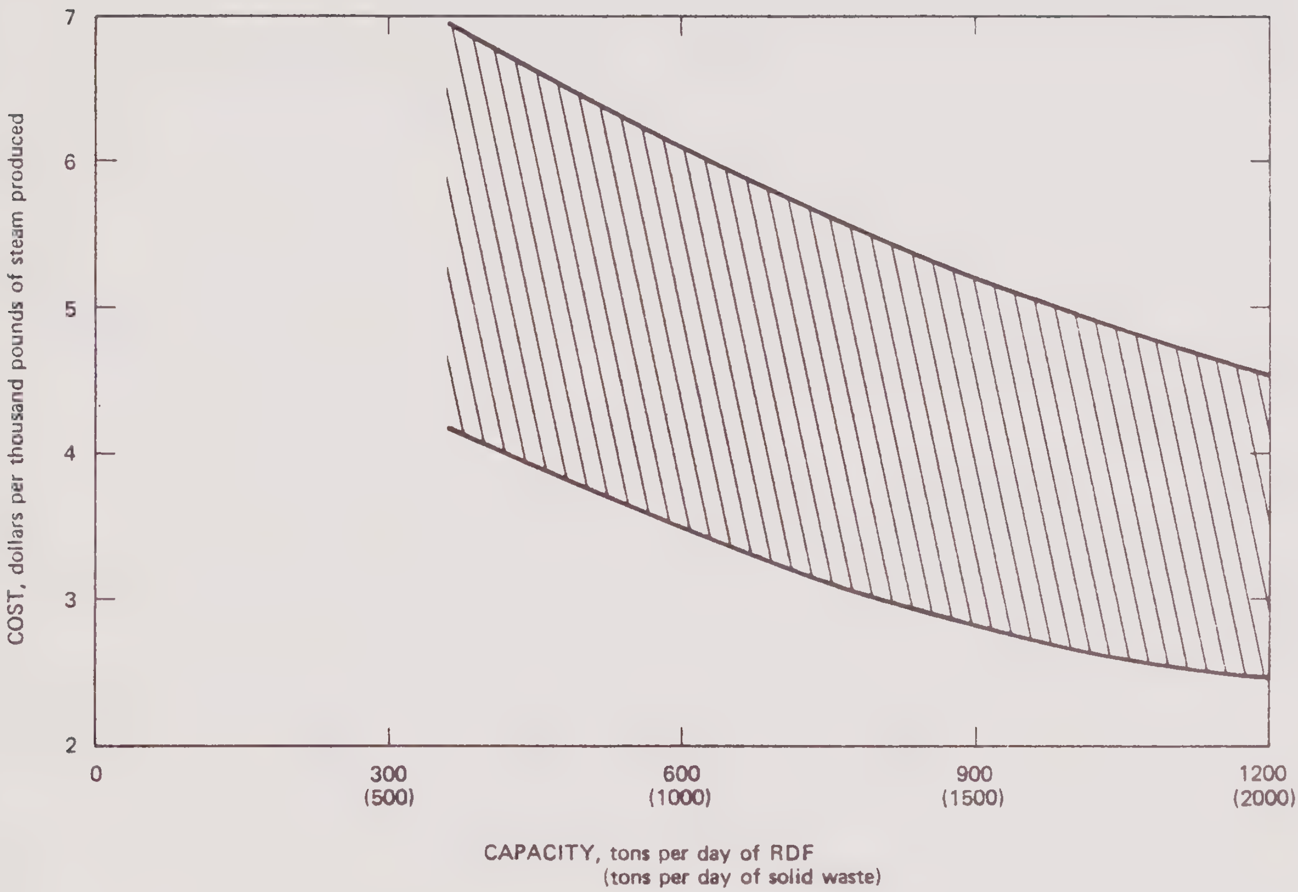


Fig. I-14 Cost of Steam Production in Energy Recovery System

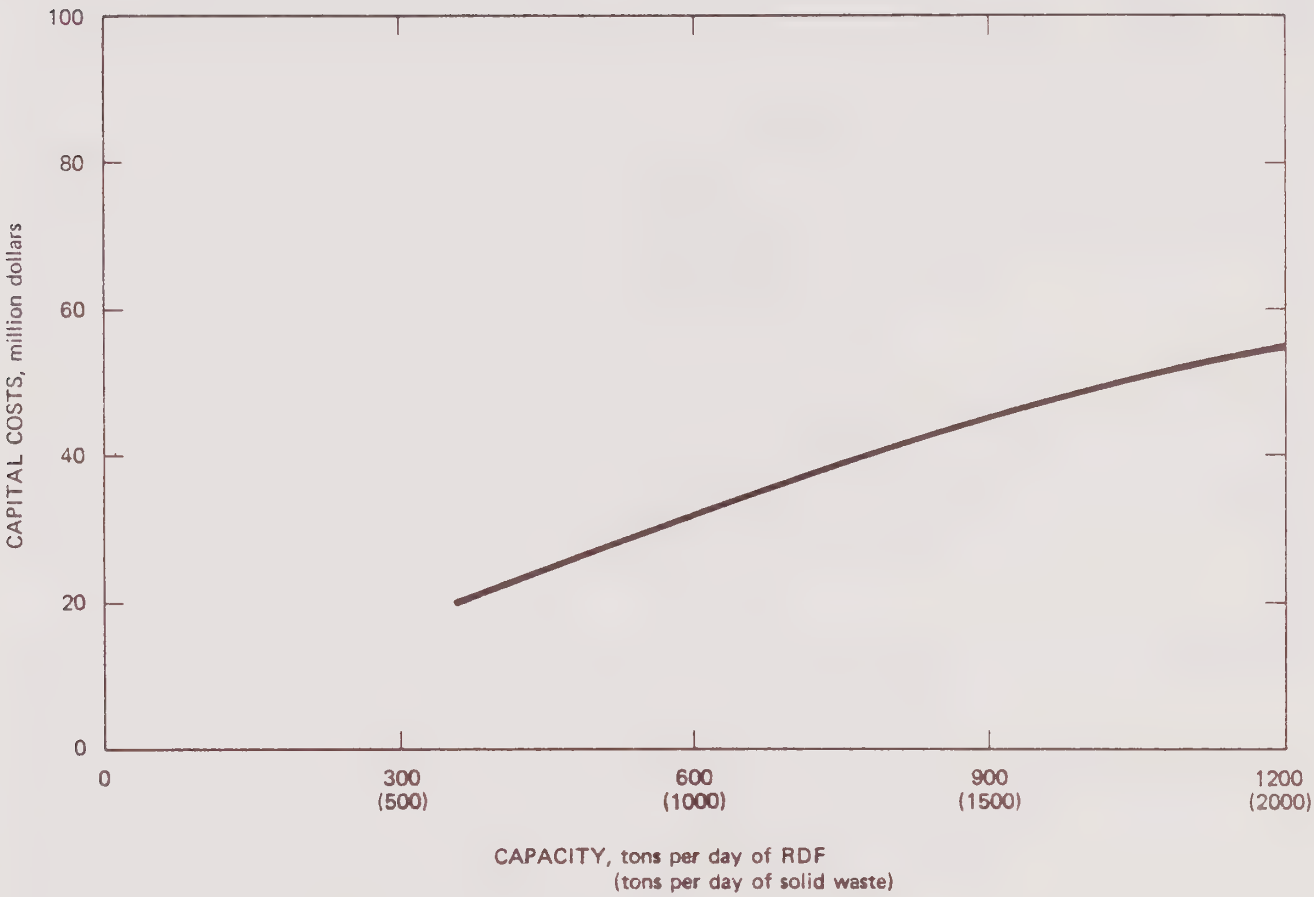


Fig. I-15 Capital Costs of Fuel Gas (Syngas) Producing Energy Recovery System (ENR 3100)

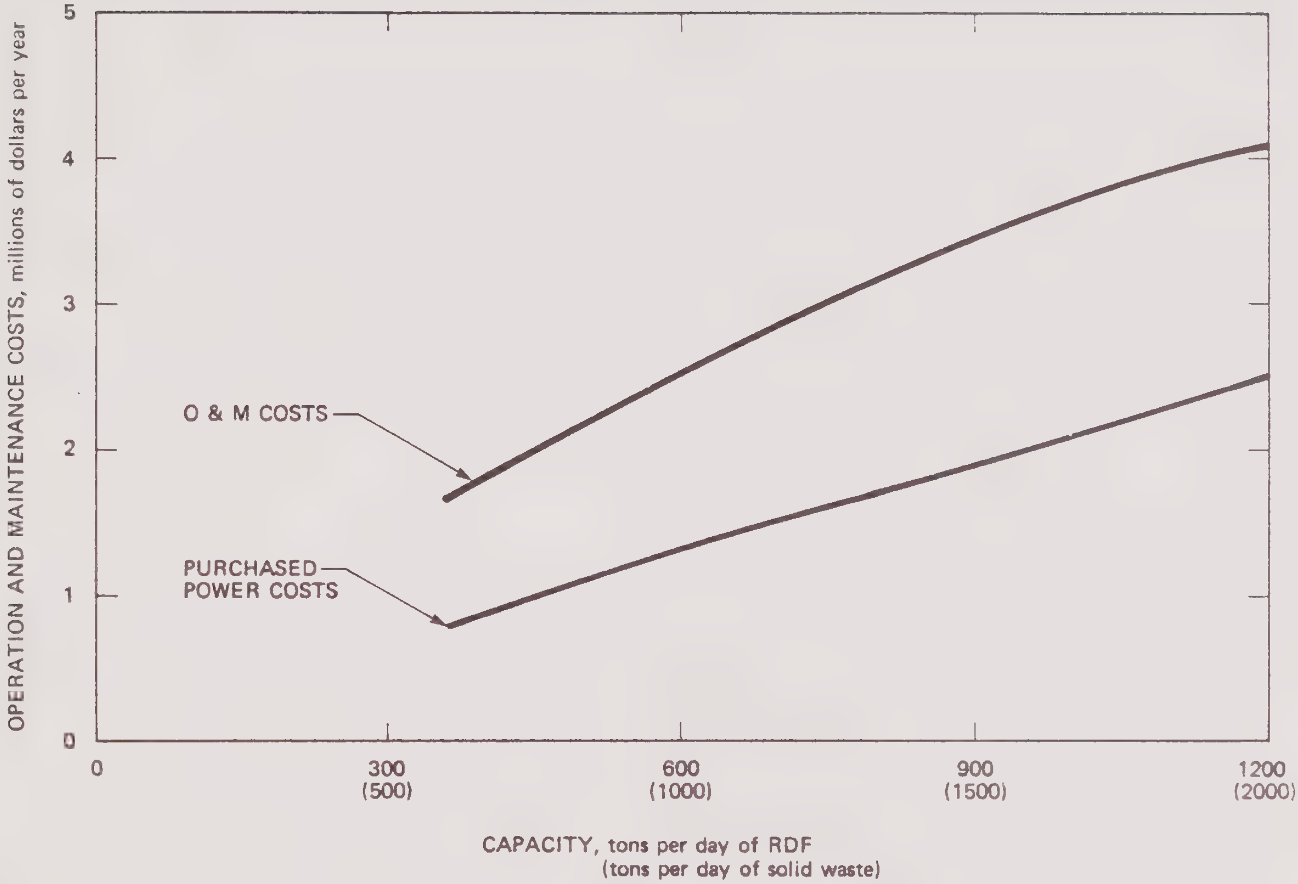


Fig. I-16 Operation and Maintenance Costs of Fuel Gas (Syngas) Energy Recovery System

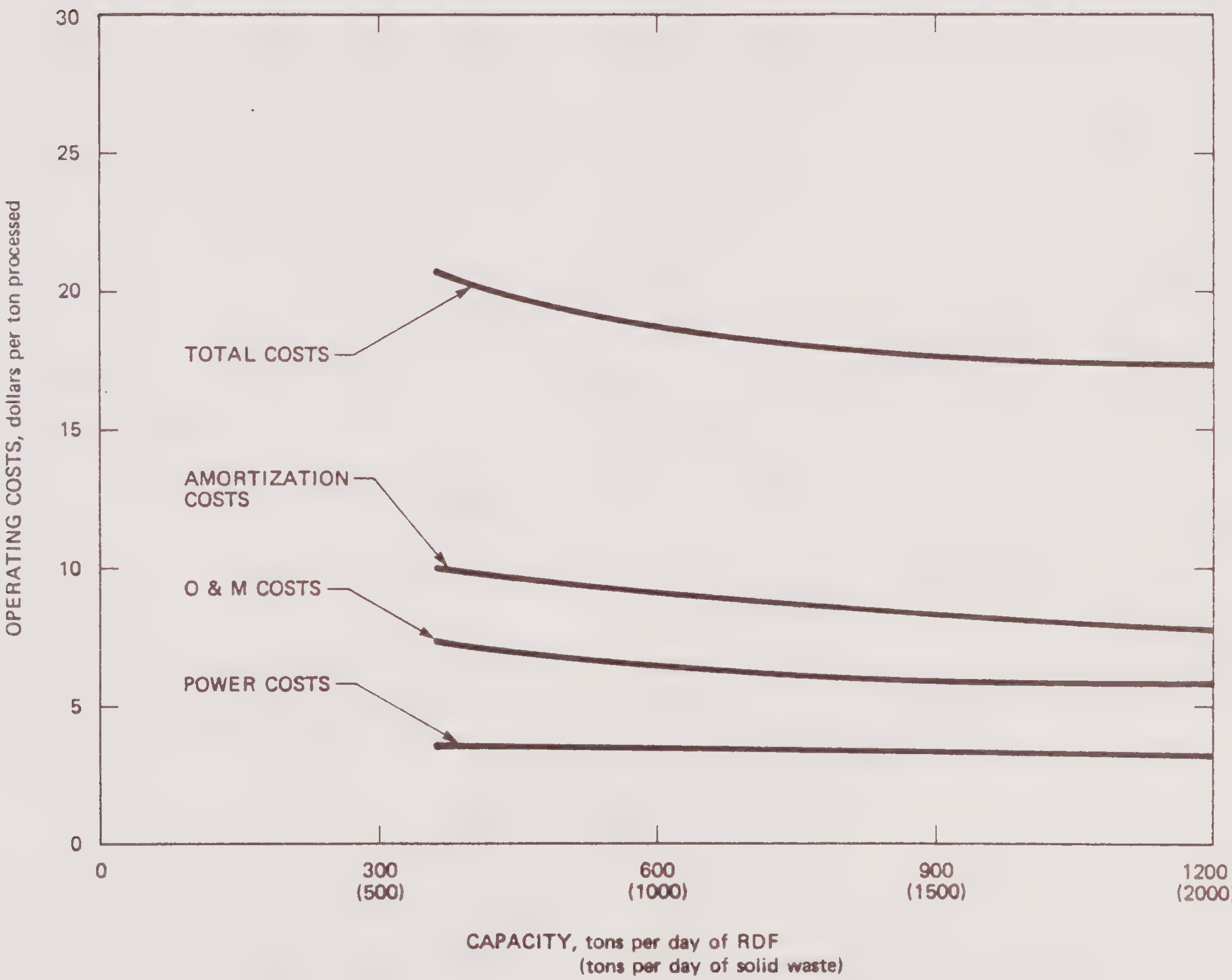


Fig. I-17 Unit Costs of Fuel Gas (Syngas) Producing Energy Recovery System

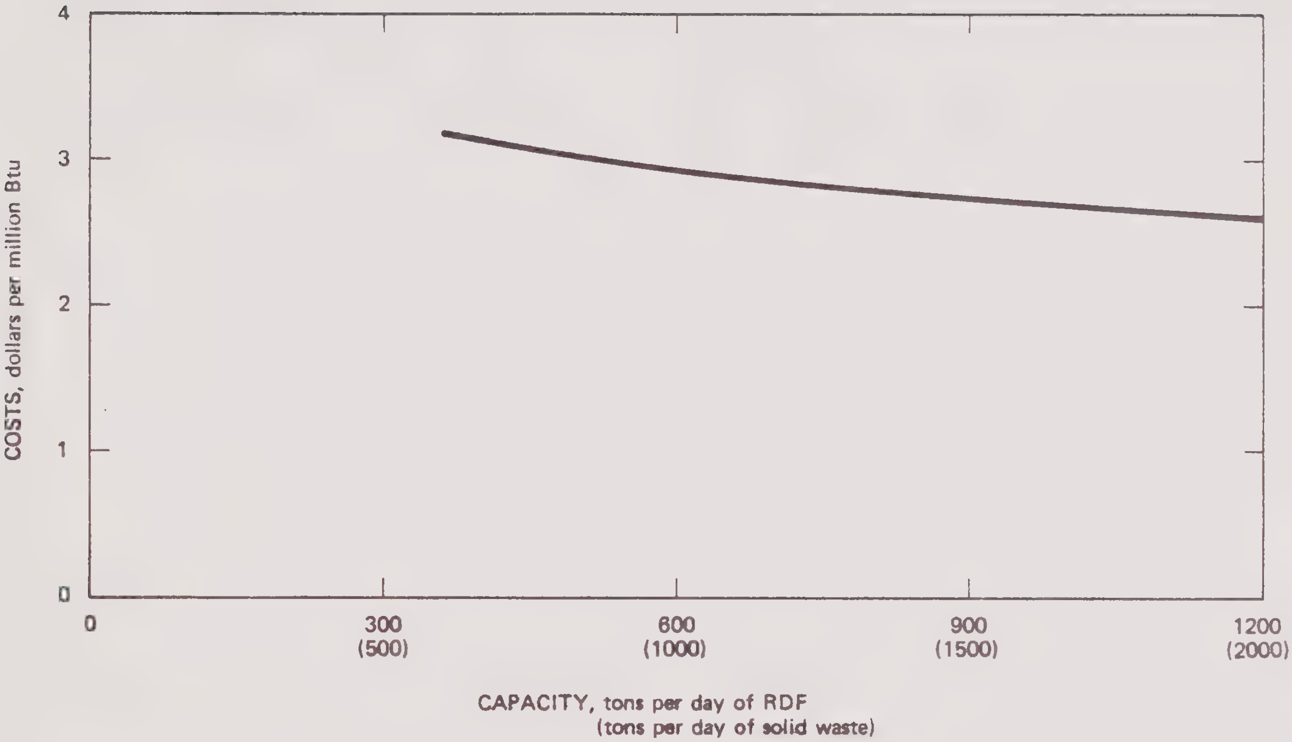


Fig. I-18 Cost of Fuel Gas Production in Energy Recovery System

a waste-to-energy facility. On the federal level, EPA has established standards of performance for municipal solid waste incinerators. In January 1978, EPA published proposed emission standards of performance for new, modified or reconstructed electric utility steam generating units that burn fossil fuel or a combination of fossil fuels and other fuels, e.g., solid wastes.

Generally, solid waste furnaces will have to comply with the following federal standards:

- National Ambient Air Quality Standards.
- Standards of Performance for New Stationary Sources, subparts A and E.
- New Source Review Rule.
- Regulations Pertaining to Prevention of Significant Deterioration of Air Quality.

Recently (March 1978), EPA announced that it will propose modifications to its emissions offset policy that will have the effect of permitting construction of new resource recovery plants in areas that fail to meet existing ambient air quality standards. At this point, it is impossible to project what the final form of this regulation will be; however, if implemented, it will considerably ease siting constraints on resource recovery facilities.

In addition to the applicable federal standards, the emissions will have to comply with local regulations. A basic problem in evaluating any emission is predicting the effect on the overall air basin. Projecting emissions and the resulting air quality is, at best, an imperfect science. Air basins in which critical air quality levels are consistently exceeded have been studied by detail sampling and have been the object of mathematical modeling. Both approaches have had mixed results.

National Ambient Air Quality Standards (NAAQS)

Federal air quality regulations are derived from the Clean Air Act Amendments of 1970, the Energy Supply and Environmental Coordination Act of 1974, and most recently, the Clean Air Act Amendments of 1977. The NAAQS are designed to protect public health and welfare and are established at threshold levels below which no adverse effects would occur. Air pollutants are divided into two groups: primary pollutants and secondary pollutants. Primary pollutants are those emitted directly from sources, while secondary pollutants are formed by chemical and photochemical reactions in the atmosphere. Primary pollutants include carbon

monoxide (CO), hydrocarbons (organic gases), oxides of nitrogen (NO_x), sulfur dioxide (SO_2), and total suspended particulates (TSP). Photochemical oxidants and nitrogen dioxide (NO_2) are the principal secondary pollutants. Nitrogen dioxide is a visible brown-yellow haze. The formation of secondary pollutants is dependent upon the availability of sunlight as much as the emission of primary pollutants that are converted to secondary pollutants. Health effects of contaminants are summarized in Table I-4. Federal primary standards were to be achieved in 1977 and secondary standards in a reasonable period of time, whereas state standards are considered goals without a specified time for compliance.

The 1970 Amendments to the Clean Air Act require the states to develop implementation plans to meet the federal standards by 1975 or 1977, depending on the severity of the state's air quality problems. The 1977 Amendments have delayed attainment deadlines and have detailed some appropriate control measures. For "nonattainment areas," those which have not yet attained NAAQS, states must have an approved implementation plan revision by July 1, 1979, which provides for attainment by December 31, 1982. If a state cannot attain primary standards for carbon monoxide or photochemical oxidants, it must submit a second plan revision by December 31, 1982, which provides for attainment by December 31, 1987. For areas which are cleaner than NAAQS, implementation plans must include a program to prevent significant deterioration of air quality. EPA guidelines require the implementation plans to provide for emission controls, transportation controls, source monitoring, ambient air quality monitoring, and a procedure for review and approval of new sources of air pollution prior to construction. EPA has the authority to approve or disapprove these plans and to promulgate an acceptable plan if the submitted plan is disapproved. EPA, state air resources boards, and local air pollution control districts also have the authority to restrict issuance of permits for construction of stationary sources if emissions from that source would cause the violation of any air quality standard. In both nonattainment and nondegradation areas, major stationary sources may be constructed only by permit and must at least meet new source performance standards. At present Alameda County may be considered a nonattainment area with respect to particulates, nitrogen oxides, photochemical oxidants and sulfur oxides.

Standards of Performance for New Stationary Sources (NSPS)

Subpart A of NSPS involves general provisions covering definitions, performance tests, authority, monitoring requirements, etc. Subpart E is applicable to all incinerators with a charging rate greater than 50 tons per day with municipal refuse comprising more than 50 percent of the charge. Subpart E requires that particulates discharged be no greater than 0.08 grains/sdcf, corrected to 12 percent carbon dioxide.

Table I-4. Health Effects of Air Pollution

Air quality level	Pollutant levels: TSP (24-hour), $\mu g/m^3$	SO_2 (24-hour), $\mu g/m^3$	CO (8-hour), mg/m^3	O_3 (1-hour), $\mu g/m^3$	NO_2 (1-hour), $\mu g/m^3$	Health effect descriptor	General health effects	Cautionary statements
Significant harm	1000	2620	57.5	1200	3750			
						Hazardous	Premature death of ill and elderly. Healthy people will experience adverse symptoms that affect their normal activity.	All persons should remain indoors, keeping windows and doors closed. All persons should minimize physical exertion and avoid traffic.
Emergency	875	2100	40.0	1000	3000			
							Premature onset of certain diseases in addition to significant aggravation of symptoms and decreased exercise tolerance in healthy persons.	Elderly and persons with existing diseases should stay indoors and avoid physical exertion. General population should avoid outdoor activity.
Warning	625	1600	34.0	800	2260			
						Very unhealthful	Significant aggravation of symptoms and decreased exercise tolerance in persons with heart or lung disease, with widespread symptoms in the healthy population.	Elderly and persons with existing heart or lung disease should stay indoors and reduce physical activity.
Alert	375	800	17.0	400[c]	1130			
						Unhealthful	Mild aggravation of symptoms in susceptible persons, with irritation symptoms in the healthy population.	Persons with existing heart or respiratory ailments should reduce physical exertion and outdoor activity.
NAAQS	260	365	10.0	160	a			
						Moderate	–	–
50 percent of NAAQS	75[b]	80[b]	5.0	80	a			
						Good	–	–
	0	0	0	0	a			

[a]No index values reported at concentration levels below those specified by "Alert Level" criteria.

[b]Annual primary NAAQS.

[c]400 ug/m^3 was used instead of the O_3 Alert Level of 200 ug/m^3 (see text).

Source: EPA, Environmental News, August 23, 1976.

New Source Review Standards (NSR)

This regulation, 40 CFR 52.18, requires a preconstruction review of all stationary sources to determine if the source will meet all applicable emission requirements of the State Implementation Plans.

The reviewing authority is the Bay Area Air Pollution Control District (BAAPCD) which can apply stricter emission standards than the EPA regulations. In areas where the NAAQS is being violated, emission trade-offs, or offsets, in the air basin may be required prior to acceptance of the new source.

Prevention of Significant Deterioration (PSD)

This regulation, 40 CFR 52.21, limits increases in particulate and sulfur dioxide concentrations above base levels measured in designated areas. Data on total emissions for the entire air basin are required to evaluate incremental increases in specific emissions due to operation of any new furnaces.

Local Regulations

The BAAPCD is responsible for policing nonvehicular sources of air pollution in the Bay Area. Permits must be applied for before commencing construction of facilities that will have air emissions, and plans and specifications must be submitted for review. The permit can be denied if it is determined that the facility will not meet the district's standards, or would cause any air quality standards to be exceeded, or if source related air quality in the vicinity of the proposed site is already exceeded. A second evaluation by the district is required after construction is completed before it will be permitted to operate.

In general, BAAPCD has adopted emission standards similar to those promulated by the EPA. Legislation governing NSR standards, however, is currently under review. New sources or modifications to existing sources that emit more than 15 lb/hr or 150 lb/day of a regulated contaminant must apply best available control technology. Sources emitting more than 25 lb/hr or 250 lb/day of any contaminant in areas which comply with state or national air quality standards must prove that the emissions from the new or modified source will not cause a violation of, or interfere with, the attainment or maintenance of these standards. Otherwise, or if the proposed site is in a noncompliance area, offsets must be obtained. The trade-off policy aims at offsetting new emissions by a factor of a least 1.2 lb/lb of contaminant in new emissions.

The BAAPCD limit of 250 lb/day is more stringent than the existing federal standard (40 CFR 51.18) of 100 tons/yr (550 lb/day,) although EPA has tentatively proposed a new value of

50 tons/yr (275 lb/day). A recent development in air quality regulations may have a significant impact on a resource recovery project. The BAAPCD has adopted a new source review rule that may permit construction of new resource recovery plants in areas that fail to meet existing ambient air quality standards without requiring offsets. The provision is included to encourage construction of facilities that represent "significant advances in the development of a technology that appears to offer extraordinary environmental or public health benefits, or other benefits of overriding importance to the public health or welfare." The application of this provision requires concurrence by the State Air Board and EPA.

Projected Air Emissions

The predicted concentrations of three primary pollutants in the exhaust gases discharged to the atmosphere in each of the four selected energy recovery processes are presented in Table I-5.

In establishing these concentrations, it has been assumed that each process will be equipped with an air cleaning system designed to clean the air down to 0.005 g/sdcf.

The lower concentration for $S0_x$ in the MHF system is attributed to sulfur remaining in the ash during pyrolysis. The relatively low value of NO_x of the Purox system is attributed to the absence of nitrogen in the pyrolysis step since this process uses pure oxygen for pyrolysis. The high value of 125 ppm for the NO_x in the MHF exhaust is based on test results where 80 to 100 percent excess air is used for combustion. Under actual long-term operation, less than 50 percent excess air could be utilized, with consequent reduction of nitrogen oxide emissions.

Division 3 of Regulation 7 of BAAPCD requires that incinerators burning solid wastes discharge gases containing less than 0.08 g/sdcf. Division 3 of Regulation 2 states that the maximum allowable concentration of SO_x shall be 300 ppm. Divison 14 of Regulation 2 gives maximum allowable concentration of NO_x in gases from gaseous fossil fuel burning of 125 ppm or 175 pm, depending on the maximum heat input to the heat transfer operation.

None of the concentrations shown in Table I-5 exceeds these limits. The range of hourly emissions are shown in Table I-6 for typical facility capacities. The mass emission rates in some cases exceed BAAPCD limits (2.5 lb/hr) above which offsets (trade-offs) are normally required.

It appears that SO_x and NO_x offsets may be required, unless variances can be obtained for facilities processing 1,000 TPD or more, as the 25 lb/hr or 250 lb/day limits will be exceeded.

Table I-5. Projected Controlled Concentrations of Primary Pollutants in Off-Gases From Four Energy Recovery Processes

Process[a]	Pollutant				
	CO, ppm	SO_x, ppm	NO_x, ppm	Particulates, gr/scf	Nonmethane hydrocarbon
Waterwall incineration	150	50	150	0.005	25
M.H.F. pyrolysis	<10	50	125	0.005	<10
Purox	Not applicable (Product is a gas)				
Andco Torrax	<10	125	115	0.005	<10
Regulations	-	300	125	0.08	25

[a]Assumes baghouse followed by wet scrubber.

Table I-6. Projected Controlled Hourly Emissions of Primary Pollutants

Emissions	Capacity of facility			
	800 TPD	1,000 TPD	1,500 TPD	2,000 TPD
SO_x, lb/hr	20 to 85	35 to 140	55 to 215	70 to 285
NO_x, lb/hr	25 to 80	40 to 135	55 to 200	75 to 270
Particulates, lb/hr	1.7 to 3.0	2.9 to 5.1	4.3 to 7.6	5.7 to 10.1
CO, lb/hr	5 to 80	6 to 100	10 to 150	12 to 200
Nonmethane hydrocarbon	5 to 8	6 to 10	9 to 15	12 to 20

Smaller facilities may require offsets, depending on the energy recovery process selected. MHF pyrolysis and waterwall incineration may exceed the NO_x limits but not the SO_x limits. The Purox process is likely to exceed SO_x limits but may not exceed NO_x limits. A 600-TPD Andco-Torrax system without a variance would require both SO_x and NO_x trade-offs.

The particulate emissions are well below limits, primarily because it has been assumed that all processes will be equipped with air cleaning devices such as electrostatic precipitators, fiber filters and scrubbers, which can generally clean air down to 0.005 g/sdcf. These low particulate emissions may be taken into account when required offsets are determined.

COST-EFFECTIVENESS OF ENERGY CONVERSION SYSTEMS

The recommendation of a single process from the six processes retained after the secondary screening stage, cannot be made at this time. However, it can be determined whether energy recovery is cost-effective and also which is the apparent best energy form, if energy recovery is to be practiced.

Table I-7 presents a summary of average energy production for each form of energy considered, unit production costs, estimated sale prices and net system losses at 1995 RDF production level. None of the processes considered are cost-effective. Average unit production costs in all cases exceed the estimated sale prices by a substantial margin. The escalation of costs for competing fuels could result in much higher revenues in 1995 and cost-effectiveness might improve in future years. The unit cost level to which competing fuel prices must rise to make energy conversion of solid waste cost-effective is \$.045/kWhr for electricity, \$4.55/1000 lb for steam and \$3.40/MM Btu for fuel gas.

It appears from Table I-7 that production of gas is the least economically attractive energy system. However, it is cautioned that the gas system costs reflect those of the Purox system, whereas the steam and electricity system costs are averaged from a range of costs. These average costs are lower than the Purox system costs because of the influence of the lower cost multiple-hearth and waterwall incineration systems.

The most economically attractive system appears to be steam generation. However, as discussed in the section on markets, even though the entire county steam consumption is considerable, most steam users are widely dispersed and it is believed that construction of a large number of steam plants to serve the individual needs is not economically attractive.

Table I-7. Summary of Cost-Effectiveness of Waste-to-Energy Conversion Systems

Item/unit	Net production, average	Unit production cost, dollars[a] average	Unit sale price, dollars[b]	Unit gain (loss), dollars	Profit (deficit), million dollars/yea
Electricity, kWhr/year	3.2×10^8	0.045/kWhr	0.03/kWhr	(0.015/kWhr)	(4.8)
Steam, lb/year	3.9×10^9	4.55/1,000 lb 3.25/MM BTU	2.50/1,000 lb 1.80/MM BTU	(2.05/1,000 lb) (1.45/MM BTU)	(8)
Medium BTU gas, BTU/year	5.7×10^{12}	3.40/MM BTU	2.50/MM BTU	(0.90/MM BTU)	(5.1)

[a]Costs are based on 1977 conditions and no payment for RDF fuel.

[b]Sale price is based on 1977 conditions.

Sale of electricity is selected as the best apparent option, even though it is not the most economically attractive alternative. The primary reasons for making this selection are:

- Cogeneration is being actively pursued by utility companies in an effort to supplement their generating capacity.
- Electricity generation costs are rapidly escalating.
- Connection to an existing electricity grid would probably be the simplest and least costly system to maintain and operate. Independent gas and steam transportation and distribution networks will require increased maintenance, and in the case of medium Btu gas, considerable health and safety precautions will be required.
- Utilization of municipal waste for production of electricity will result in an overall reduced consumption of natural resources, thus releasing the available resources for more efficient uses.

REFERENCES

1. Resource Recovery Plant Implementation: Guides for Municipal Officials - Technologies, U.S. Environmental Protection Agency, 1976.

2. Jones, Jerry, "Converting Solid Wastes and Residues to Fuel," Chemical Engineering, 85(1), January 2, 1978, pp. 87-94.

3. Resource Recovery Technology for Urban Decision Makers, Urban Technology Center, January 1976.

APPENDIX J

PROJECT FINANCING ALTERNATIVES

APPENDIX J

PROJECT FINANCING ALTERNATIVES

It is the purpose of this appendix to enumerate, in general terms, the methods available for financing solid waste management facilities. There numerous financing methods available include various forms of both public and private sector financing and combinations thereof. For a detailed discussion of these financing methods the reader is referred to the references at the end of this appendix. Each of the financing methods was analyzed to determine their best use for the facilities programs presented in this report.

Public Financing

Public agencies can select a financing plan from a wide range of financing methods when contemplating the financing of capital projects. These choices range from the use of current revenues (pay-as-you-go) and short-term bank loans for small projects to long-term municipal bonds for large projects. A compendium of public financing methods together with a description of their salient features is presented below.

General Obligation (G.O.) Municipal Bonds. General obligation municipal bonds are long-term obligations secured by the "full faith and credit" (general tax revenues) of the political jurisdiction issuing the bonds. Although these bonds cannot be offered by the Joint Powers Authority (JPA), they can be issued by any of the participating agencies. This is generally the easiest most versatile, and least costly method of bond financing. Advantages of this type of financing include:

- Lowest interest rates of all public bond financing.
- Lowest issue costs in that the project being funded requires no analysis and no bond reserve fund is required.
- Most versatile in that several municipal projects can be funded from a single issue.

Some constraints associated with this type of financing include:

- Requires two-thirds voter approval.
- Can only be issued by jurisdictions having the power to levy ad valorem taxes.

- Amount of issue is limited by jurisdictions debt limit.

Municipal Revenue Bonds. Municipal revenue bonds are long-term obligations secured by the net revenues generated by the project being funded. In the case of solid waste management facilities these revenues could include tipping fees, sale of recovered resources and energy and lease payments. Revenue bonds can be issued by either the JPA or any of the participating agencies. Revenue Bond can be issued under the Revenue Bond Law of 1941 or the Revenue Bond Law of 1933. The former requires a majority of voter approval while the latter does not require voter approval but requires that the bond-holders receive a first lien on revenues prior to previous or subsequent liens. This makes future issues of revenue bonds unlikely. Advantages of revenue bond financing include:

- Does not require voter approval (1933 Act Bonds) or requires only majority approval (1941 Act Bonds), compared to two-thirds voter approval required for G.O. Bonds.

- Can be issued by the JPA.

- No effect on jurisictions debt limitation.

Major constraints include:

- Higher cost than G.O. bonds resulting from higher interest rate, required technical and economic analysis of project, and required maximum year debt service reserve.

- Less versatile than G.O. bonds in that the bonds can only be issued for specific project.

Lease Revenue Bonds. Although technically a form of municipal revenue bond financing, this method of financing can be used in the case where public ownership and private operation is being considered. Bonds can be issued by a public agency and facilities leased to a private operator with the bonds being secured by both the guaranteed lease revenues (rather than project revenues) and the assets of the lease. This type of financing has the same advantages and constraints as regular municipal revenue bond financing; however, it is likely to result in a slightly lower interest rate due to the reduced risk associated with guaranteed lease payments rather than uncertain project revenues.

Bank Loans. Bank loans or notes are generally short or intermediate obligations secured either by the promise-to-pay or by the assets being financed. Bank loans are generally for periods

less than five years, however they can, in certain instances, run for as long as 10 years. This type of financing is practical in the case where project costs are relatively small and/or are partly supported by grant aid. Advantages of bank loans include:

- Low cost in that interest costs are comparable to G.O. or revenue bonds while issue costs are lower.

- Easy to implement.

Constraints are:

- Relatively short term.

- Cannot be used for very large projects.

Leasing. Although theoretically speaking leasing is a financing method it differs from the other financing methods presented above in that it does not actually involve the borrowing of monies. Besides being extremely high in cost (interest costs are approximately twice those of municipal bonds) lease periods are short (limited by California law to not longer than one year for cities and counties) and thus this method is not practical except as an interim measure while a more permanent method of financing is being arranged.

Current Revenues - (pay-as-you-go). Small projects can be financed directly from current revenues. Larger projects, planned far enough in advance and/or with staged construction schedules such that front-end costs are not large, can also be financed on a pay-as-you-go basis. Obvious advantages include:

- Lowest cost method of financing.

- Easiest method to implement.

Constraints include:

- Limited in terms of revenues required per rate or tax payer.

- Possible lack of equity in that future user may not pay fair share.

Private Financing

In addition to the above methods of public financing of solid waste management facilities, the JPA or any of the participating agencies has the alternative of contracting with a private firm to raise capital, purchase the facilities and operate the system. This is in fact, the method currently employed by most of the participating agencies in the Alameda County Solid Waste Management

Authority (Berkeley, Alameda, Pleasanton and a portion of San Leandro excepted). Methods of private financing are catalogued below.

Private Debt. As in the case of public agencies, private companies can borrow money via either the bond market or bank loans. Unlike the case of municipal borrowing, however, interest payments on private debt are not tax exempt and thus interest costs are generally 30 to 50 percent higher than for a similarly rated municipal bond. In addition the deterioration of the condition of the capital markets since 1969 has limited bond financing to only the most credit worthy (major blue chip) companies, making bank loan financing the only source of capital for many companies. Interest on bank loans and notes generally range from 1/2 point to 2-1/2 points above the prime rate depending on the credit rating of the borrower. As in the case of municipal borrowers the interest cost associated with private bond financing is approximately the same as that associated with bank loans. Other bond costs such as issue costs and costs associated with sinking fund requirements are probably similar in magnitude to loan fees, points, and compensating-balance costs associated with bank loans.

Traditionally bonds were associated with long-term capital needs while bank loans were essentially for short-term capital requirements. This distinction has since bleared, and bank loans in the form of perpetual lines of credit or the continuous rollover of short term notes can sometimes be used in lieu of long-term bonds.

Private Equity. Some sort of equity is almost always associated with private debt. Equity takes the form of either capital stock, paid-in capital in excess of par value and/or retained earning. Because of entrepreneurial and financial risk the cost of equity capital is much greater than the cost of debt. Investors currently require a 16 to 20 percent return before taxes on equity capital.

Solid Waste Disposal Revenue Bonds. In addition to the traditional forms of private financing indicated above, there exists a class of tax exempt bonds, broadly classified as Industrial Revenue Bonds, that can be used to finance projects whose specific purpose is the control of pollution. In California these bonds, referred to as Solid Waste Disposal Revenue Bonds, are issued by the California Pollution Control Financing Authority (CPCFA) and are secured by the lease or purchase agreement between the issuing agency and the private owner/operator. For tax purposes the facilities are considered to be owned by the private owner, if payments between owner and municipality are in the form of an installment sale. Although interest to the bond holders is

tax exempt, the tax benefits of the deduction of either accelerated depreciation or investment tax credit and normal depreciation together with interest payments accrue to the owner.

Leveraged Leasing. A financing method which combines the benefits of low-cost, tax-exempt interest rate and the advantages of private ownership is leveraged leasing. Here a financial intermediary (e.g., a bank leasing subsidiary) owns the facilities. The capitalization consists of both equity and debt. The debt portion is borrowed from the public agency. The public agency raises the funds to lend to the financial intermediary through the issue of a tax exempt G.O. or revenue bond. The financial intermediary, in turn, leases the waste management facility to an operating company. The financial intermediary acquires the tax advantages of ownership (depreciation and investment tax credits) together with the low cost of money (municipal bond interest rates). This enables the public agency to finance necessary facilities at a lower cost than municipal bonds.

Advantages of private financing and operation include:

- Reduces demand on municipal debt limits
- Availability of technical expertise that might not be available in the public sector
- Lower interest cost in case of leveraged leasing

Constraints include:

- Legally complex
- Loss of control of operation
- Higher capital costs in cases other than leveraged leasing

The financing methods summarized in this appendix will be evaluated as to their appropriateness in terms of cost and ease of implementation for each of the alternative mid- and long-term facilities plans.

REFERENCES

1. Resource Recovery Plant Implementation: Guides for Municipal Officials - Financing, U.S. Environment Protection Agency's Office of Solid Waste Management Programs.

2. Study of Financing Methodology, White, Weld & Co. Incorporated, December 1976.

3. Financial Methods for Solid Waste Facilities, Resource Planning Associates, 1974.

APPENDIX K

ENERGY ANALYSIS

APPENDIX K

ENERGY ANALYSIS

The energy requirements of each of the four alternative facilities programs presented in Chapter 2 are presented in this appendix. The energy requirements of each of the alternative facilities programs are important considerations in the evaluation and selection of a final facilities program. Only the internal energy requirements of the programs are discussed. Potenital energy savings associated with the manufacture of products from recycled materials was not considered because it was outside the scope of work and the energy requirements of collection, source separation or community recycling centers is common to all alternatives and, therefore, its determination was not useful in this comparative analysis.

BASIS OF ESTIMATES

In developing the energy requirements, a number of assumptions were made on the energy demands of the various facilities. These assumptions are:

- Collection vehicles are assumed to haul 7.5 tons/load.
- Collection vehicles are assumed to average 4 miles/gal (mpg) in hual situations.
- Transfer vehicles are assumed to haul 22 tons/load.
- Transfer vehicles are assumed to average 5 mpg.
- Transfer vehicles convey waste materials from the transfer stations to the landfills or the resource recovery facility.
- Transfer vehicles convey waste materials from the resource recovery facility and the energy production facility to the landfills.
- No energy demands are presented for transporting RDF from the resource recovery facility to the energy production facility.

- Fuel requirements for the operation of the four large transfer stations (560 TPD, 610 TPD, 810 TPD, and 840 TPD) are assumed to be 30 gal/hr (gph); operation time is assumed to be 10 hr/day, 7 days a week.

- Fuel requirements for the operation of the smaller transfer station is assumed to be 15 gph; operation time is assumed to be 8 hr/day, 7 days a week.

- Power requirements for the transfer stations are assumed to be 1500 kWhr/100 TPD capacity/year.

- Energy conversion efficiency is assumed to be 30 percent, i.e., 1 kWhr = 11,400 Btu.

- Fuel is assumed to be diesel fuel with an energy value of 138,000 Btu/gal.

- Annual power requirements for the resource recovery facility are assumed to be 14.3 kWhr per processed ton.[1]

- All power figures presented for the energy production facility in Appendix I are presented as net power production figures.

- Fuel requirements for landfill are assumed to be 160 gal/1,000 tons landfilled.[2]

All energy analyses are presented for the 1995 planning year only. The 1985 energy requirements for each of the alternative programs would be approximately two-thirds of the 1995 energy requirements.

ENERGY DEMANDS

Fuel and power demands are presented below for each of the four alternative facilities programs. Energy usage is presented on an annual basis of MMBtu for each program to allow a direct comparison of total energy demand.

Alternative 1

The annual fuel requirements for direct long haul and disposal with collection vehicles is presented in Table K-1. Based on the conversion factors presented above, this represents an annual energy demand of 3.7×10^5 MMBtu.

Table K-1. Fuel Consumption for Alternative 1, 1995

Waste generation area	Annual collection vehicle distance traveled, miles	Annual collection vehicle fuel consumption, gallons	Annual landfill fuel consumption, gallons	Total annual fuel consumption, gallons
Alameda	730,000	182,500	11,700	194,200
Albany	131,400	32,900	1,800	34,700
Berkeley	1,365,100	341,300	19,300	360,600
Castro Valley Sanitary District	243,300	60,800	5,800	66,600
Dublin-San Ramon Services District	116,800	29,200	3,500	32,700
Emeryville	38,900	9,700	600	10,300
Fremont	1,423,500	355,900	26,300	382,200
Hayward	730,000	182,500	14,600	197,100
Livermore	87,600	21,900	10,500	32,400
Newark	401,500	100,400	6,400	106,800
North Oakland	1,596,300	399,100	23,900	423,000
South Oakland	1,396,700	349,200	23,900	373,100
Oro Loma Sanitary District	669,200	167,300	14,600	181,900
Piedmont	116,800	29,200	1,800	31,000
Pleasanton	187,400	46,900	6,400	53,300
San Leandro	321,200	80,300	6,400	86,700
Union City	442,900	110,700	7,600	118,300
County Total	9,998,600	2,499,800	185,100	2,684,900

Alternative 2

The fuel requirements for transportation and landfill operations for indirect haul through transfer stations are presented in Table K-2. The operation of the transfer stations will require an additional 481,800 gal and 4.5×10^6 kWhr annually. Thus, the total annual energy requirements for this alternative are 2.1×10^5 MMBtu.

Alternative 3

Fuel consumption for transportation and landfill operations for resource recovery with and without sales of RDF are presented in Tables K-3 and K-4. The collection vehicle fuel requirements are the same as for Alternative 2. The analysis and the resulting data presented in Tables K-3 and K-4 assume that the resource recovery facility is located at the South Oakland Transfer Station. Disposal vehicle fuel consumption is based on the use of transfer vehicles to transport the residue from the operation of the resource recovery facility. Power requirements for the transfer stations are the same as for Alternative 2.

The resource recovery facility will require 16.5×10^6 kWhr/year. Total power requirements for the operation of the transfer stations and the resource recovery facility represent an annual energy consumption of 2.4×10^5 MMBtu.

The fuel consumption summarized in Table K-3 represents an annual energy requirement of 1×10^5 MMBtu. The total annual energy requirement for resource recovery with the sale of RDF is 3.4×10^5 MMBtu.

The fuel consumption summarized in Table K-4 represents an annual energy requirement of 1.9×10^5 MMBtu. The annual energy requirement for resource recovery without the sale of RDF is 4.3×10^5 MMBtu.

Alternative 4

Fuel requirements for transportation and landfill operations for energy production are presented in Table K-5. These fuel requirements are essentially the same as the fuel requirements for Alternative 3 with RDF sales but there is an increased consumption in disposal vehicle fuel requirements and landfill operations based on the disposal of the ash from the combustion of the RDF.

For this analysis, it was assumed that the energy production facility and the resource recovery facility were located at the South Oakland transfer station.

Table K-2. Fuel Consumption for Transportation and Landfill Operations for Alternative 2, 1995

Waste generation area	Annual collection distance traveled, miles	Annual collection vehicle fuel consumption, gallons	Annual transfer vehicle distance traveled, miles	Annual transfer vehicle fuel consumption, gallons	Annual landfill fuel consumption, gallons	Annual fuel consumption,[a] gallons
Alameda	68,100	17,000	232,300	46,500	11,700	75,200
Albany	19,000	4,800	39,800	8,000	1,800	14,600
Berkeley	112,400	28,100	438,000	87,600	19,300	135,000
Castro Valley Sanitary District	48,700	12,200	99,500	19,900	5,300	37,900
Dublin-San Ramon Services District	46,700	11,700	29,900	6,000	3,500	21,200
Emeryville	1,900	500	13,300	2,700	600	3,800
Fremont	262,800	67,000	485,300	97,100	26,300	190,400
Hayward	60,800	15,200	248,900	49,800	14,600	79,600
Livermore	87,600	21,900	NA	NA	10,500	32,400
Newark	85,700	21,400	118,600	23,700	6,400	51,500
North Oakland	139,700	34,900	544,200	108,800	23,900	167,600
South Oakland	79,800	20,000	476,200	95,200	23,900	139,100
Oro Loma Sanitary District	60,800	15,200	248,900	49,800	14,600	79,500
Piedmont	8,800	2,200	39,800	8,000	1,800	12,000
Pleasanton	26,800	6,700	54,800	11,000	6,400	24,100
San Leandro	53,500	13,400	109,500	21,900	6,400	41,700
Union City	82,200	20,600	129,400	25,900	7,600	54,100
County Totals	1,245,300	312,800	3,308,400	661,900	185,100	1,159,800

[a] Not including fuel consumption at the transfer stations (see text).

Table K-3. Fuel Consumption for Transportation and Landfill Operations for Alternative 3 With RDF Sale, 1995

Waste generation area	Annual collection vehicle fuel consumption, gallons[a]	Annual transfer vehicle distance traveled, miles	Annual transfer vehicle fuel consumption, gallons	Annual disposal vehicle fuel consumption,[b] gallons	Annual landfill fuel consumption, gallons[b]	Annual fuel consumption, gallons
Alameda	17,000	0	0	6,500	1,600	[illegible]
Albany	4,800	7,500	1,500	1,000	300	[illegible]
Berkeley	28,100	82,100	16,400	10,700	2,700	[illegible]
Castro Valley Sanitary District	12,200	26,500	5,300	3,300	800	[illegible]
Dublin-San Ramon Services District	11,700	44,800	9,000	2,000	500	23,200
Emeryville	500	2,500	500	300	100	1,400
Fremont	67,000	373,300	74,700	14,600	3,700	160,000
Hayward	15,200	66,400	13,300	8,100	2,000	38,600
Livermore	39,400[c]	134,400	26,900	5,900	1,500	73,700
Newark	21,400	91,300	18,300	3,600	900	44,200
North Oakland	34,900	102,000	20,400	13,300	3,300	71,900
South Oakland	20,000	0	0	13,300	3,300	36,600
Oro Loma Sanitary District	15,200	66,400	13,300	8,100	2,000	38,600
Piedmont	2,200	7,500	1,500	1,100	300	5,000
Pleasanton	6,700	82,100	16,400	3,600	900	27,6[illegible]
San Leandro	13,400	29,200	5,800	3,600	900	23,700
Union City	20,600	107,800	21,600	4,200	1,100	47,500
County Total	330,300	1,223,800	244,900	103,100	25,900	704,200

[a] From Table K-2.

[b] Based on landfilling, 14 percent of the solid waste stream in 1995.

[c] Based on 18-mile roundtrip from Livermore to Pleasanton transfer station.

Table K-4. Fuel Consumption for Transportation and Landfill Operations for Alternative 4 Without RDF Sales, 1995

Waste generation area	Annual collection vehicle fuel consumption,[a] gallons	Annual transfer vehicle fuel consumption, gallons	Annual disposal vehicle fuel consumption,[b] gallons	Annual landfill fuel consumption,[b] gallons	Annual fuel consumption, gallons
Alameda	17,000	0	41,300	10,200	68,500
Albany	4,800	1,500	6,400	1,900	14,600
Berkeley	28,100	16,400	68,000	17,200	129,700
Castro Valley Sanitary District	12,200	5,300	21,000	5,100	43,600
Dublin-San Ramon Services District	11,700	9,000	12,700	3,200	36,600
Emeryville	500	500	1,900	600	3,500
Fremont	67,000	74,700	92,800	23,500	258,000
Hayward	15,200	13,300	51,500	12,700	92,700
Livermore	39,400	26,900	37,500	9,500	113,300
Newark	21,400	18,300	22,900	5,700	68,300
North Oakland	34,900	20,400	84,600	21,000	160,800
South Oakland	20,000	0	84,600	21,000	125,600
Oro Loma Sanitary District	15,200	13,300	51,500	12,700	92,700
Piedmont	2,200	1,500	6,400	1,900	12,000
Pleasanton	6,700	16,400	22,900	5,700	51,700
San Leandro	13,400	5,800	22,900	5,700	47,800
Union City	20,600	21,600	26,700	7,000	75,900
County Total	330,300	244,900	655,600	164,600	1,395,300

[a]From Table K-1.

[b]Based on landfilling, 89 percent of the solid waste stream.

Table K-5. Fuel Consumption for Alternative 4, 1995

Waste generation area	Annual collection vehicle fuel consumption,[a] gallons	Annual transfer vehicle distance traveled,[b] miles	Annual transfer vehicle fuel consumption,[b] gallons	Annual disposal vehicle fuel consumption,[c] gallons	Annual landfill fuel consumption,[c] gallons	Annual fuel consumption, gallons
Alameda	17,000	0	0	8,800	2,200	28,000
Albany	4,800	7,500	1,500	1,400	400	9,100
Berkeley	28,100	82,100	16,400	14,500	3,700	62,700
Castro Valley Sanitary District	12,200	26,500	5,300	4,500	1,100	23,100
Dublin-San Ramon Services District	11,700	44,800	9,000	2,700	700	24,100
Emeryville	500	2,500	500	400	100	1,500
Fremont	67,000	373,300	74,700	19,800	5,000	166,500
Hayward	15,200	66,400	13,300	11,000	2,700	42,200
Livermore	39,400[d]	134,400	26,900	8,000	2,000	76,300
Newark	21,400	91,300	18,300	4,900	1,200	45,800
North Oakland	34,900	102,000	20,400	18,100	4,500	77,900
South Oakland	20,000	0	0	18,100	4,500	42,600
Oro Loma Sanitary District	15,200	66,400	13,300	11,000	2,700	42,200
Piedmont	2,200	7,500	1,500	1,400	400	5,500
Pleasanton	6,700	82,100	16,400	4,900	1,200	29,200
San Leandro	13,400	29,200	5,800	4,900	1,200	25,300
Union City	20,600	107,800	21,600	5,700	1,500	49,400
County Total	330,300	1,223,800	244,900	140,100	35,100	750,400

[a] From Table K-2.

[b] From Table K-3.

[c] Based on landfilling 19 percent of the solid waste stream in 1995.

[d] Based on 10-mile roundtrip from Livermore to Pleasanton Transfer Station.

Total fuel requirements for transportation and landfilling operations in Table K-5 represent an annual energy demand of 1 X 10^5 MMBtu. Power requirements for operation of the transfer stations and resource recovery facility are the same as for Alternative 3, i.e., 2.4 X 10^5 MMBtu. Thus, total energy requirements for transportation, processing and landfill operations are 3.4 X 10^5 MMBtu.

The energy production facility has an annual net production of 3.2 X 10^8 KWhr. If this amount of electricity was generated using diesel fuel, it would require the consumption of 2.6 X 10^7 gal of fuel/year or the equivalent of 3.6 X 10^6 MMBtu/year.

Thus, Alternative 4 yields an energy surplus of 3.26 X 10^6 MMBtu/year based on the use of diesel fuel to develop the equivalent amount of energy expressed as Btu from the electricity generated under Alternative 4.

SUMMARY OF ENERGY REQUIREMENTS

Table K-6 presents the energy requirements of each of the components of the alternative facilities. Alternative 4 actually provides more equivalent energy than it consumes. Of the remaining alternatives, Alternative 2 consumes less energy than either Alternatives 1 or 3. Alternative 3 with sale of RDF consumes less energy than Alternative 1 or Alternative 3 without the sale of RDF. Alternative 1 consumes roughly 10 percent less energy than Alternative 3 without the sale of RDF neglecting the energy benefit of recycling materials instead of producing new material from raw ore.

REFERENCES

1. National Center for Resource Recovery, New Orleans Resource Recovery Facility, Implementation Study, September 1977.

2. County of Sacramento, Department of Public Works, Division of Solid Waste Management, Sacramento County Solid Waste Management Plan, April 1976.

Table K-6. Summary of Energy Requirements of Alternative Facilities Programs, 1995 (MM Btu x 10^5)

Component	Alternative 1	Alternative 2	Alternative 3		Alternative 4
			With RDF sales	Without RDF sales	
Transportation					
Collection vehicle	3.4	0.4	0.5	0.5	0.5
Transfer vehicle	--	0.9	0.3	0.3	0.3
Disposal vehicle	--	--	0.2	0.9	0.2
Landfill operation	0.3	0.3	0.04	0.2	0.05
Transfer station operation	--	0.5	0.5	0.5	0.5
Resource recovery facility operation	--	--	1.9	1.9	1.9
(Benefit) from production of electricity	--	--	--	--	(36)
Total requirement (or net production) per year	3.7	2.1	3.4	4.3	(33)

APPENDIX L

ALTERNATIVE MEDIUM- AND LONG-TERM SOLID WASTE FACILITIES PROGRAMS FOR ALAMEDA COUNTY

APPENDIX L

ALTERNATIVE MEDIUM- AND LONG-TERM SOLID WASTE FACILITIES PROGRAMS FOR ALAMEDA COUNTY

This appendix presents four alternative facilities programs for Alameda County. The alternative programs contain facility systems which provide for recovery of materials from the waste stream, producing energy where a market exists to use it in Alameda County, and the landfilling of all unrecovered wastes and residues from recovery facilities. The topics discussed include the development of the alternatives, the existing solid waste system in Alameda County, preliminary exclusions in developing the alternative programs, and the alternative programs. The programs are:

Alternative 1: Direct Long Haul by Collection Vehicles

Alternative 2: Indirect Long Haul Through Transfer Stations

Alternative 3: Recovery of Material from Solid Waste

Alternative 4: Materials Recovery and Energy Production

Although presented as alternatives and, thus, different options for facilities in the medium- and long-term future, these alternatives can represent the sequence of actions needed to achieve maximum resource recovery.

In the next 5 years in Alameda County, all the landfills now operating in the West County area will probably be closed. There will be at the most two landfills which will be in operation, and they are both located in the East County area near Livermore. The reader is referred to Appendix A of this report and the Alameda County short-term facilities plan for a more in-depth discussion of landfills.

A significant amount of information developed during the formulation of these alternative programs is presented in various appendices of this report. The appropriate appendix should be reviewed for more information as the subjects are considered in this appendix.

DEVELOPMENT OF ALTERNATIVE SYSTEMS

In developing alternative facilities programs, variations of each program were investigated to determine the arrangements that are most cost-effective. For brevity, only the most cost-effective

variation is presented here. Readers interested in the selection of the most cost-effective variation of each program are directed to Appendix E for transfer station analysis, Appendix H for cost-effectiveness of various sizes of resource recovery facilities, and Appendix I for review of energy recovery systems.

Programs Common to All Alternatives

There are many items which are not specifically addressed in these alternative programs which are common to all the programs. Three of the most important are collection, source separation and community recycling centers. The collection system has not been evaluated, since any economics or adjustments in the collection system would uniformly affect all the programs presented herein. Similarly, source separation programs would uniformly affect the quantities of waste collected and processed in all alternatives. Historically, source separation programs have not seriously affected the quantities of wastes which must be collected and/or processed.

Community recycling centers have been in operation for more than five years in Alameda County. These centers have increased in number and size as citizen and business support increases. These centers function as locations where citizens can bring material for recycling and, thus, assist in source separation efforts. A summary of these projects is presented in the Solid Waste Management Plan for Alameda County. The largest recycler in Alameda County is located in Berkeley and recycles approximately 3 percent of Berkeley's solid waste.

Source separation is considered the best technique currently available for recovering paper products for reuse as fiber feedstock to produce recycled paper and cellulose insulation. However, recovery rates are generally very low in source separation programs (10 to 15 percent), and successful programs may require legislation and intensive public education programs. These are policy decisions which are appropriate to the policy plan, not this facilities plan.

A final note regarding common programs concerns the administrative responsibility of the Authority versus local agency responsibility. The three program areas, collection, source separation, and community recycling centers, are the responsibility of local agencies. Each program, by definition, implies local community action. The Authority has a passive role in these programs.

The facilities plan presents programs through which the Authority and other regional agencies can adequately administer the handling of all solid wastes generated in Alameda County.

Definition of Medium- and Long-Term Planning Periods

For the purposes of this plan, 1995 has been taken as the appropriate year for the evaluation of long-term facilities, and 1985 has been taken as the appropriate year for the evaluation of medium-term facilities. These specific years were selected to aid in the evaluation of facility size and cost-effectiveness. The cost-effectiveness of facility variations are for 1995. The most cost-effective variation is then evaluated to determine if it would be cost-effective in 1985. If the facilities are cost-effective in 1985, then a brief implementation schedule is presented.

Alameda County has an adopted short-term facilities plan which covers the years to 1980. Thus, implementation of facilities discussed in this plan is assumed to have occurred prior to 1980 if cost-effective or by 1985 or 1995 if they are indicated to be cost-effective for the medium- and long-term future.

There are a number of programs which are part of solid waste management in Alameda County but are not discussed in this chapter. These programs include the management of hazardous waste, including infectious and radioactive materials, water and wastewater treatment plant sludges, demolition wastes and industrial wastes and litter. Most of the programs to handle these wastes are under the jurisdiction of other public agencies or they do not significantly impact the solid waste stream considered in developing these alternatives. The industrial wastes are primarily recycled to other producers and thus do not reach the waste stream considered here. Demolition waste quantities, however, are significant and might present a problem of such magnitude that if adequate disposal sites in the West County areas are not found, illegal dumping may become a problem. Similarly, there are no Class I (hazardous waste) disposal sites in Alameda County. Locating a Class I disposal site either in or nearby the county would provide for adequate disposal capacity for these wastes generated in Alameda County. More information on these waste programs is presented in Appendix A.

Solid Waste System in Alameda County

There are sixteen agencies in Alameda County which have the responsibility to provide, or contract for, the collection and disposal of solid waste in Alameda County. Twelve of these agencies have franchise agreements with the Oakland Scavenger Company. The Cities of Berkeley and San Leandro provide their own collection services. Berkeley provides its own disposal service, the City of Pleasanton contracts for collection and disposal with the Pleasanton Collection Service, while the City of Alameda provides its own disposal while contracting with Alameda City Disposal Service for collection.

Table A-11 contains a definitive list of the waste collectors and disposers for each agency in Alameda County. There are currently six landfills operating in Alameda County and one new landfill which is intended to be opened in 1979. Of the six operating landfills, one has reached capacity, one will be closed by the end of 1978, one will close in 1979 unless an extension, which is being sought, is granted, and two will close by 1982. These landfills are all located along the shore of San Francisco Bay. The only two landfills which will operate after 1982 are the East County landfill located on Vasco Road approximately two miles north of Interstate Highway 580, and the Altamont landfill, still to be opened, which is located approximately three miles northeast of the intersection of Altamont Pass Road and Interstate Highway 580.

Waste Generation Areas. In order that the sixteen agencies responsible for solid waste handling in Alameda County can review and comment on the facilities programs as it pertains to them, each of the agencies was assumed to constitute a "waste generation area" (see Appendix B for a definition of waste generation areas). The costs of the alternatives are presented, to the fullest extent possible, for each waste generation area to simplify the evaluation of the impact of each alternative on each agency. Data on the population in, and quantities of solid waste generated by, each waste generation area are presented in Appendices B and C.

Preliminary Exclusions

Certain assumptions were made during the development of the alternatives that have significant impact on their content and in the interpretation of their programs. These assumptions are highlighted here to provide the background needed to understand the approach and methodology used in developing the alternatives.

Baling to Increase Density. The possibility of extending the life of existing landfills by increasing the density of the solid waste by baling or the utilization of more compaction equipment was not considered. The life of the existing landfills is so short that extension of the landfill operation by these methods would not significantly affect the need for the medium- and long-term facilities.

Data from the Short-Term Plan. The short-term facilities plan for Alameda County included a suggested outline for the medium- and long-term facilities plan. The order of that outline was not followed since the outline included mandates that facilities be implemented by certain dates regardless of their cost-effectiveness at the time. The outline also included a mandated approach to the selection of required facilities, i.e., that transfer stations and resource recovery facilities would be included regardless of the

economics or other factors which might be involved. This, also, was considered to be too constraining for a viable community plan for medium- and long-term facilities and hence was not followed. However, the essence of that outline as it was interpreted here is presented in the alternatives of this chapter.

Interpretation of Goals from the Policy Plan. There are a number of statements in the policy plan which were not followed in the development of the alternatives since they were felt to be too constraining or unrealistic. These statements are listed below:

- "The first priority alternative for the 1980-1990 planning period is Alternative 1990-C which is a full-scale material and energy recovery system to achieve 92 percent resource recovery. The system would include two full-scale processing/energy recovery facilities, and wastes from all four planning units would be processed. This system represents the optimum goal; many hurdles remain in the interim." Page I-4, Reference 1.

- "Transfer facilities will be needed for the metropolitan area of Alameda County (Albany to Hayward) and should be located to efficiently serve collection routes in each area. Such facilities would separate ferrous and non-ferrous metals, reusable fibers (wood and paper), glass and other materials for which adequate markets exist. They would apply the most feasible proven technology to this program." Page I-10, Reference 1.

- "In view of the vast virgin resources and low cullet value, glass recycling appears neither likely to 'carry its own weight' nor be of great importance in terms of resource conservation." Page VIII-9, Reference 1.

- "If maximum conservation of resources (including energy) is a primary goal, then materials in solid waste should be recovered through composting rather than converted to energy." Page VIII-21, Reference 1.

- "Industry and individual companies should be encouraged to recover and revise their own waste products through legal sanctions." Page VIII-21, Reference 1.

These statements were felt to constrain the development of the facilities plan and, thus, were not explicitly followed in the development of the medium- and long-term facilities program.

THE ALTERNATIVES

The alternative facilities programs presented below are considered the best variations of each alternative but are based on assumptions of cost, equipment size and efficiency, operating hours, and capabilities which can change from system to system and agency to agency. These facilities programs do not evaluate any current proposals and are not intended to be site specific. Therefore, the community constraints and specific problems associated with sites, transportation routes, etc., are not presented here since they are not now known. The incorporation of these social, political and institutional constraints into the facilities plan occurred during the public hearings. The alternative programs presented here ignore such constraints with the evaluations being restricted to the presentation of the most cost-effective variation for each alternative.

Alternative 1 - Direct Long Haul by Collection Vechicles

In this plan, collection vehicles would carry wastes from the end of the collection routes in the various waste generation areas directly over highways to landfills in East County. Due to the closure of landfills in West County before 1980, this alternative is essentially a "no action" alternative.

Location of Facilities. The location of the two landfills in East County is shown on Figure L-1. Although it is quite likely that new collection vehicles may be required to economically cover this distance, this study did not evaluate the economics of the collection systems or attempt to determine if existing equipment is suitable for long haul disposal.

Description of Alternative. Solid waste would be collected by the various collectors in Alameda County and the waste would be hauled in the collection vehicle to the landfills located in the East County area. In evaluating the economics of this alternative, it has been assumed that:

- Vehicles traveling from the West County area would be left at various staging areas, and new drivers would shuttle the vehicles to the landfills, e.g., haul costs presented here are for one-man crews. Supporting cost data are presented in Appendix D.

- The Pleasanton transfer station would continue to operate.

- Wastes from Livermore and the Dublin-San Ramon Services District would be hauled to the landfills with two-man crews.

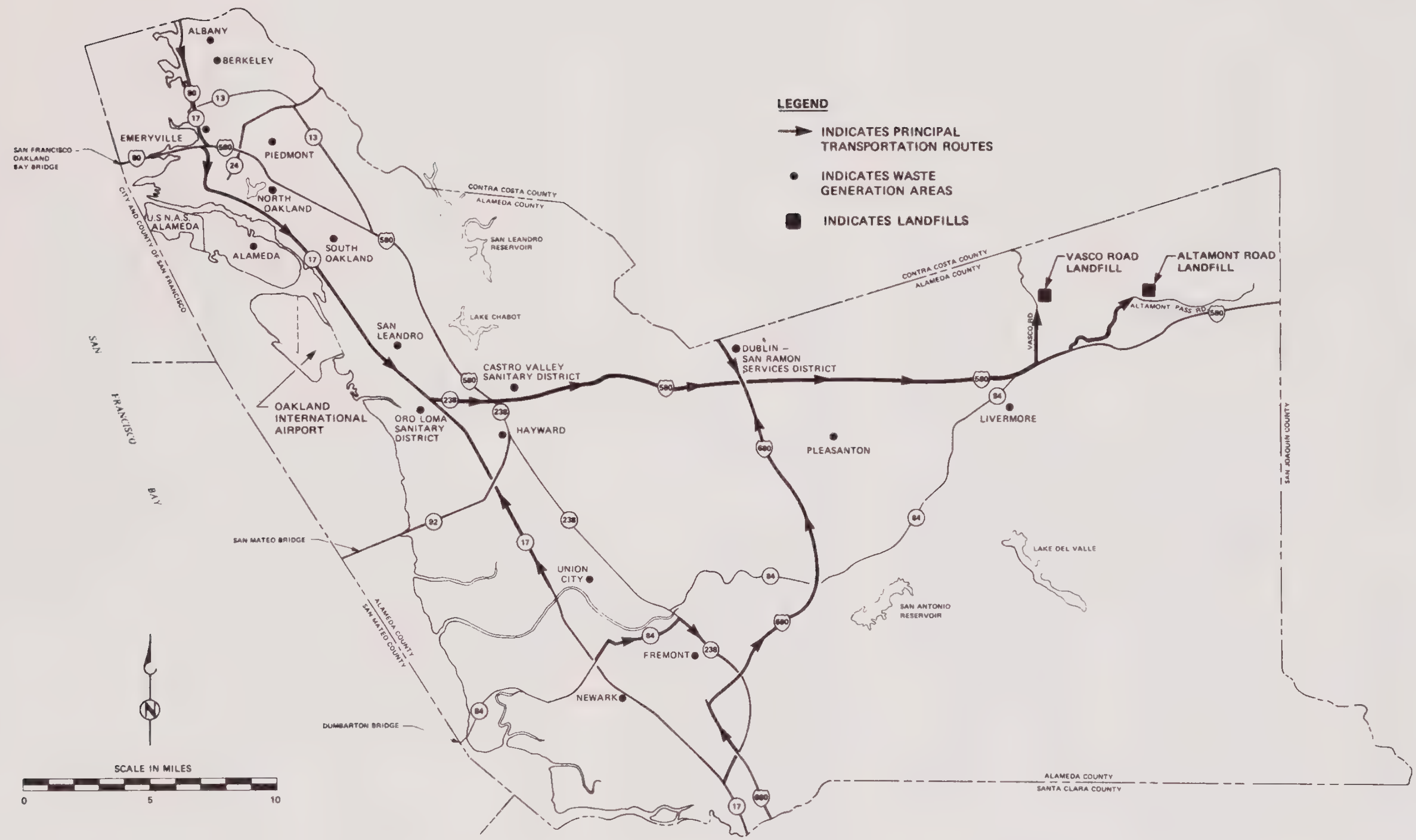


Fig. L-1 Location of Facilities for Alternative 1 - Direct Long Haul to Landfills in Eastern Alameda County

The daily operating cost of this system for 1985 and 1995 is presented in Tables L-1 and L-2. Supporting cost data are presented in Appendix D; waste quantities are developed in Appendix C.

There are currently 339,000 solid waste accounts in Alameda County. This includes all residential, commercial and front-end loader accounts. Using the population projections presented in Appendix B, as a guideline for the expected increase in county growth, there will be approximately 368,000 accounts in 1985 and 405,000 accounts in 1995.

The annual average increase in cost per account for a direct long haul alternative over current costs is approximately $40 in 1985 and $43 in 1995. Assuming an average two-can garbage collection service bill of $5.00 per month ($60 per year) in 1977, this cost for direct long haul would result in a 67 percent increase in cost over existing service in 1985 and a 72 percent increase in 1995.

Advantages and Disadvantages of Direct Long Haul. The main advantage of this alternative is that no capital investment is required in land, structures or new types of equipment. Costs would be paid by users as the costs are incurred. Some new collection vehicles may have to be purchased depending on the state of repair of the existing fleet of collection vehicles.

The disadvantages of a direct long haul system are listed below:

- Does not attempt to achieve the adopted resource recovery goals.
- Collection vehicles are tied up hauling to landfill for a good portion of the day.
- Vehicle breakdowns require long haul to repair vehicles and require a larger back-up fleet than short haul situations.
- System operation must change; less time is available for collection since more time is spent on the highway. This leads to double-shift operation or less refuse collected per truck.
- Increased manpower requirements.
- There is an increase in the number of trucks using existing highways such as Interstate 580.

The direct long haul alternative is compared to the three other alternatives at the conclusion of this appendix.

Table L-1. Economics of Direct Long Haul, 1985

Waste generation area	Waste quantity, TPD[a]	Haul distance, miles[b]	Daily haul cost, dollars[c]	Daily disposal cost, dollars[f]	Total daily cost, dollars
Alameda	180	75	2,300	700	3,000
Albany	30	90	450	100	550
Berkeley	290	85	4,200	1,100	5,300
Castro Valley Sanitary District	90	50	750	300	1,050
Dublin-San Ramon Services District	40	40	400[d]	150	550
Emeryville	10	80	150	50	200
Fremont	310	65	3,450	1,150	4,600
Hayward	220	60	2,250	800	3,050
Livermore	130	10	350[d]	500	850
Newark	80	75	1,000	300	1,300
North Oakland	370	80	5,050	1,400	6,450
South Oakland	370	70	4,400	1,400	5,800
Oro Loma Sanitary District	230	55	2,150	850	3,000
Piedmont	20	80	250	100	350
Pleasanton	80	35[g]	750[e]	300	1,050
San Leandro	90	60	900	350	1,250
Union City	90	70	1,100	350	1,450
County total	2,630	-	29,900	9,900	39,300

[a]From Table C-3.

[b]Measured roundtrip between Centroid of waste generation area and landfill. For Centroid location see Table E-1.

[c]Based on the cost of 1-man crew in collection vehicle, see Appendix D.

[d]Based on the cost of 2-man crew in collection vehicle, see Appendix D.

[e]Based on the use of the existing transfer station $100 to transfer station, $650 transfer station to landfill.

[f]Based on $3.75/ton disposal charge.

[g]Five mile roundtrip haul to transfer station, 30 miles roundtrip haul from transfer station to landfill.

Table L-2. Economics of Direct Long Haul, 1995

Waste generation area	Waste quantity, TPD[a]	Haul distance, miles[b]	Daily haul cost, dollars[c]	Daily disposal cost, dollars[f]	Total daily cost, dollars
Alameda	200	75	2,550	750	3,300
Albany	30	90	450	100	550
Berkeley	330	85	4,750	1,250	6,000
Castro Valley Sanitary District	100	50	850	400	1,250
Dublin-San Ramon Services District	60	40	600[d]	250	850
Emeryville	10	80	150	50	200
Fremont	450	65	4,950	1,700	6,650
Hayward	250	60	2,550	950	3,500
Livermore	180	10	450[d]	700	1,150
Newark	110	75	1,400	400	1,800
North Oakland	410	80	5,600	1,550	7,150
South Oakland	410	70	4,900	1,550	6,450
Oro Loma Sanitary District	250	55	2,350	950	3,300
Piedmont	30	80	400	100	500
Pleasanton	110	35[g]	1,050[e]	400	1,450
San Leandro	110	60	1,100	400	1,500
Union City	130	70	1,550	500	2,050
County total	3,170	-	35,650	12,000	47,650

[a]From Table C-3.

[b]Measured round trip between Centroid of waste generation area and landfill. For Centroid location see Table E-1.

[c]Based on the cost of 1-man crew in collection vehicle, see Appendix D.

[d]Based on the cost of 2-man crew in collection vehicle, see Appendix D.

[e]Based on the use of the existing transfer station $150 to transfer station and $900 transfer station to landfill.

[f]Based on $3.75/ton disposal charge.

[g]Five miles roundtrip haul to transfer station, 30 miles roundtrip haul from transfer station to landfill.

Alternative 2 - Indirect Long Haul through Transfer Stations

This alternative includes transfer and transportation facilities which would receive wastes from collection vehicles, transfer these wastes to larger capacity vehicles, and then transport the wastes to disposal sites. Transfer stations in the West County area are a more economical means of completing the long haul of refuse to the East County landfills than direct long haul by collection vehicles.

Location of Facilities. An evaluation of the number and location of transfer stations is presented in Appendix E. The five-transfer station configuration resulted in the least cost to the entire county so it has been selected for presentation here.

Under this alternative four new transfer stations would be constructed in the West County area. The Pleasanton transfer station would continue to operate and would receive wastes from the Dublin-San Ramon Services District waste generation area. The general locations and capacities of the transfer stations are shown on Figure L-2. Collection vehicles would deposit collected refuse at each of the transfer stations. Long haul transfer vehicles would transport the wastes over highways to the landfills in East County. The economics of this alternative are presented in Tables L-3 and L-4. The average annual cost of this program for each account in Alameda County is approximately $27 in 1985 and $29 in 1995. Assuming an average 2-can garbage collection service bill of $5 per month ($60 per year) in 1977, this cost for indirect long haul would result in a 45 percent increase in cost over existing service in 1985 and a 48 percent increase in 1995.

Timing of Facilities. The closure of landfills in the West County area will dictate the timing of the operation of the transfer facilities. A full discussion of the West County landfill situation is presented in the short-term facilities plan, including a schedule for closing sites and building replacement facilities. As the landfills are closed, transfer stations will be required to move the collected solid waste to landfills in East County.

Advantages and Disadvantages. This alternative presents considerable annual cost savings over the direct haul alternative, reduces vehicle travel to the landfill, and regionalizes collection and disposal facilities.

Primary disadvantages with this alternative are that it:

- Does not attempt to achieve the adopted resource recovery goals.

- Requires a capital investment of approximately $14 million.

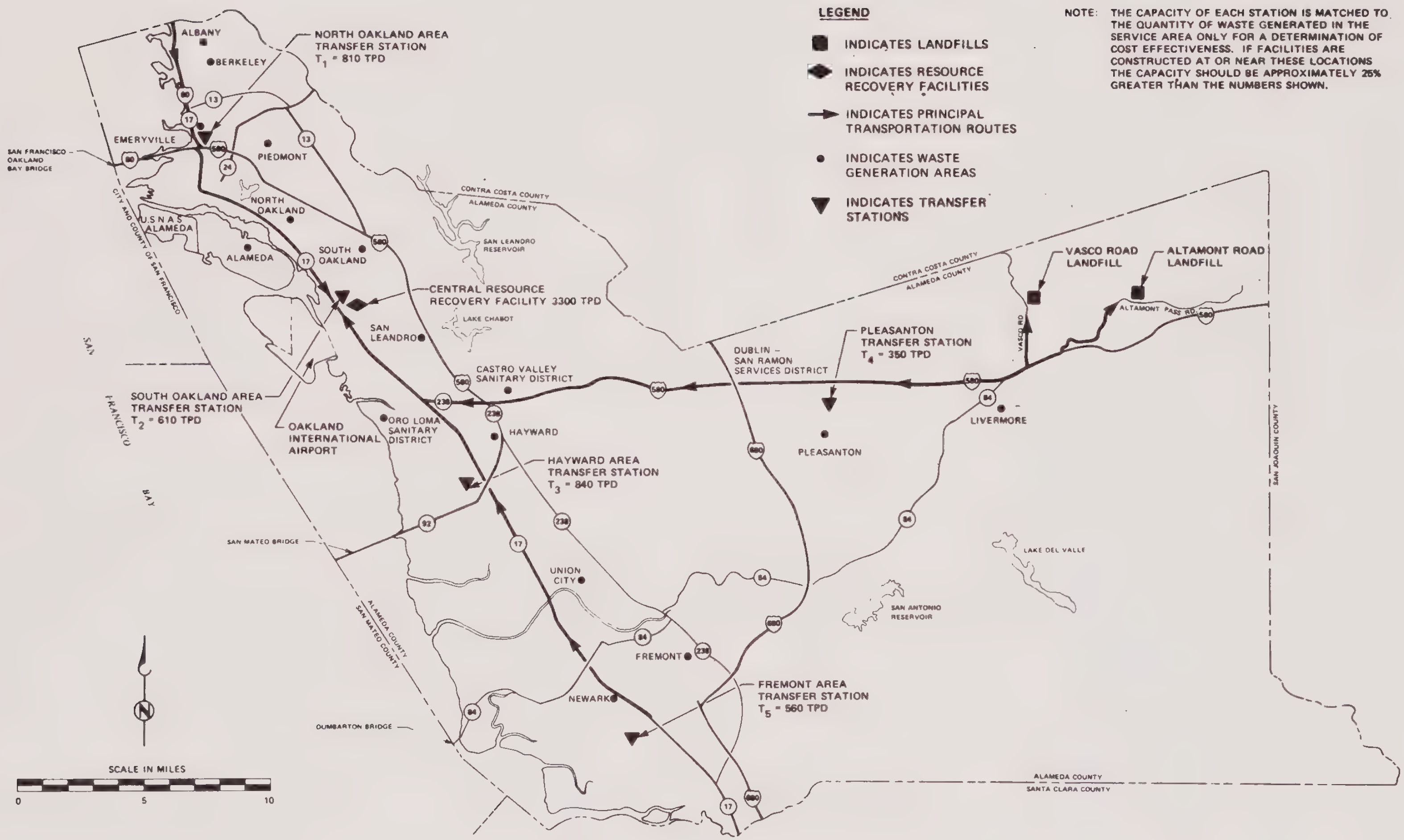


Fig. L-2 Location of Facilities for Alternative 3 – Recovery of Materials From Solid Waste

Table L-3. Economics of Alternative 2 - Indirect Long Haul Through Transfer Stations, 1985, dollars unless noted

Waste generation area	Transfer station[a]	Daily haul cost to transfer station	Daily haul cost from transfer station to landfill[c]	Daily disposal cost[d]	Total daily haul cost
Alameda	T_2	300	850	700	1,850
Albany	T_1	100	150	100	350
Berkeley	T_1	500	1,400	1,100	3,000
Castro Valley Sanitary District	T_3	200	350	350	900
Dublin-San Ramon Services District	T_4	150	300	150	600
Emeryville	T_1	10	50	50	110
Fremont	T_5	1,000	1,500	1,150	3,650
Hayward	T_3	300	900	800	2,000
Livermore	N.A.	200[b]	N.A.	500	700
Newark	T_5	300	400	300	1,000
North Oakland	T_1	650	1,300	1,400	3,850
South Oakland	T_2	400	1,750	1,400	3,550
Oro Loma Sanitary District	T_3	250	900	850	2,000
Piedmont	T_1	50	100	100	250
Pleasanton	T_4	100	600	300	1,000
San Leandro	T_3	250	350	350	950
Union City	T_3	300	350	350	1,000
Total		5,060	11,750	9,950	26,760

[a]Transfer station indicated in Table E-3.

[b]Cost of hauling to East County landfill.

[c]Cost based on size of transfer station in 1985 of:

T_1 = 720 TPD
T_2 = 610 TPD
T_3 = 720 TPD
T_4 = 120 TPD
T_5 = 390 TPD

[d]Based on $3.75/ton disposal charge.

Table L-4. Economics of Alternative 2 - Indirect Long Haul Through Transfer Stations, 1995, dollars unless noted

Waste generation area	Transfer station[a]	Daily haul cost to transfer station	Daily haul cost from transfer station to landfill	Daily disposal cost[c]	Total daily cost
Alameda	T_2	350	900	750	2,000
Albany	T_1	100	150	100	350
Berkeley	T_1	600	1,550	1,250	3,400
Castro Valley Sanitary District	T_3	250	400	400	1,050
Dublin-San Ramon Services District	T_4	250	350	250	850
Emeryville	T_1	10	50	50	110
Fremont	T_5	1,450	1,850	1,700	5,000
Hayward	T_3	350	1,000	950	2,300
Livermore	N.A.	300[b]	N.A.	700	1,000
Newark	T_5	450	500	400	1,350
North Oakland	T_1	750	1,900	1,550	4,200
South Oakland	T_2	450	1,800	1,550	3,800
Oro Loma Sanitary District	T_3	300	1,000	950	2,250
Piedmont	T_1	50	100	100	250
Pleasanton	T_4	150	600	400	1,150
San Leandro	T_3	300	400	400	1,100
Union City	T_3	450	500	500	1,450
Total		6,560	13,050	12,000	31,610

[a]Transfer station indicated in Table E-3.

[b]Cost of hauling to East County landfill.

[c]Based on $3.75/ton disposal charge.

- Requires landfill capacity for all solid wastes generated in Alameda County.

- Increases truck traffic on major highways in the county.

The indirect long haul through transfer stations is compared with the other alternatives at the conclusion of this chapter.

Alternative 3 - Recovery of Materials from Solid Waste

This alternative includes the facilities necessary to initiate large-scale resource recovery of material from the solid waste stream. The facilities are capable of receiving and handling the entire waste stream in Alameda County. An evaluation of the cost-effectiveness of large capacity plants versus smaller plants is presented in Appendix H. The most cost-effective facility for Alameda County is a single, large plant.

Location of Facilities. The use of collection vehicles to haul solid waste was compared with the cost of utilizing transfer stations to haul these wastes in Appendix E. The results of this analysis are as appropriate to the cost of hauling to resource recovery facilities as they are to hauling to landfills. In other words, it is the distance that the collection vehicles must travel and the amount of wastes they must carry which determines the economics of installing transfer stations. Thus, transfer stations proposed for Alternative 2 would be needed for this alternative.

For this analysis the resource recovery facility has been located at the South Oakland transfer station shown on Figure L-3. The resource recovery facility does not have to be located at a transfer station but haul costs are reduced when it is. For this preliminary evaluation it would not matter if the resource recovery facility were located at the Hayward or South Oakland transfer station since they are both located relatively centrally to the rest of the transfer stations.

Description of Alternative. Solid waste would be collected by the various collectors in Alameda County and the waste would be hauled in the collection vehicles to the various transfer stations in Alameda County. Waste from the transfer stations would be delivered to one central processing station. Products from the processing station would be delivered to the buyers and the remainder of material would be landfilled. Any nonprocessable wastes that can be easily separated at the transfer stations would bypass the processing station and go directly to the landfill. The resource recovery facility analysis for various size facilities is presented in Appendix H. The market analysis for recovered materials is presented in Appendix G.

As shown in Appendix H, larger resource recovery facilities are more economical than smaller facilities. Thus, only one central resource recovery facility is presented for consideration for Alameda County. Based on the costs and revenues developed for the 3,300 TPD resource recovery facility in Appendix H, the net operating cost or profit of each module was determined and is summarized in Table L-5.

By combining the values in Table L-5, a net operating profit of $8.80 per ton, which includes the cost of disposing of any residue, can be made if the market assumptions used in Appendix G remain valid and a market is developed for RDF. With partial resource recovery or with no market for RDF, the resource recovery facility will cost approximately $7.62 per ton to operate.

Tables L-6 and L-7 present the operating economics for resource recovery facilities for each waste generation area for one central plant in Alameda County both with and without a market for RDF.

These figures result in an average annual return per account of approximately $13 in 1995 if a market for RDF is found or an average annual cost per account of approximately $34 in 1995 if no market for RDF exists. Assuming an average 2-can garbage collection service bill of $5 per month ($60 per year) in 1977, this cost/profit for recovery of materials would result in a 22 percent decrease in cost over existing service in 1995 if an RDF market exists and a 57 percent increase in costs in 1995 if no RDF market exists.

Timing of Facilities. The construction of the resource recovery facility should coincide with the completion of the construction of the transfer stations. This would be in approximately 1981 or 1982. This construction sequence also coincides with the projected development of the proposed generating facility for the City of Alameda which would provide a market for the RDF produced by the resource recovery facility. Any market for RDF will greatly reduce the need for landfill capacity for solid waste in Alameda County.

Advantages and Disadvantages. All advantages from Alternative 2 carry over into this alternative. In addition, this program strives for maximum recovery of materials from the waste stream to meet the policy of nonproliferation of landfills. However, there are potential problems with this program:

- High capital cost

- Extremely dependent on market prices in what has historically been a volatile market

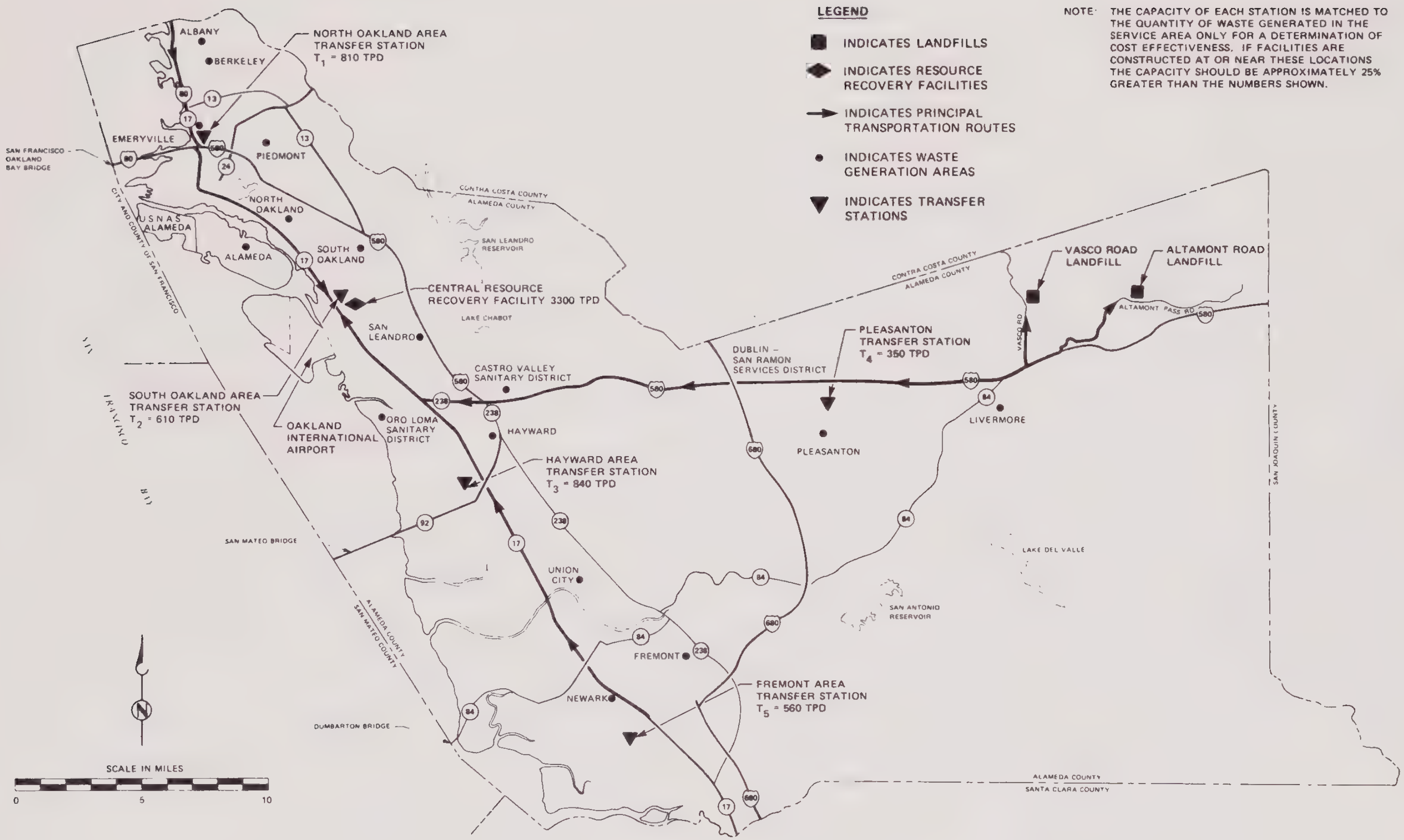


Fig. L-3 Location of Facilities for Alternative 2 - Recovery of Materials From Solid Waste

Table L-5. Economic Feasibility of Each Module in the 3,300-TPD Resource Recovery Facility

Module	Net operating (cost) or profit/ton, dollars/ton
Reduction, ferrous and support	(6.51)
Refuse derived fuel	12.40
Heavy product separation	(0.74)
Aluminum	1.85
Glass	1.80

Table L-6. Economics of Resource Recovery Alternative Assuming a Market for RDF

Waste generation area	Waste quantity, TPD[a]		Haul cost to transfer station[b]	Dollars/ton		Total (cost) or profit	Total (cost) or profit, dollars/day	
	1985	1995		Haul cost to resource recovery facility[c,d]	Net revenue from recovered material[e]		1985	1995
Alameda	180	200	1.75	0.0	8.80	7.05	1,250	1,400
Albany	30	30	3.25	2.20	8.80	3.35	100	100
Berkeley	290	330	1.75	2.20	8.80	4.85	1,400	1,600
Castro Valley Sanitary District	90	100	2.50	2.30	8.80	4.00	350	400
Dublin-San Ramon Services District	40	60	4.25	4.10	8.80	0.45	25	25
Emeryville	10	10	1.00	2.20	8.80	5.60	50	50
Fremont	310	450	1.00	3.90	8.80	3.90	1,200	1,750
Hayward	220	250	1.50	2.30	8.80	5.00	1,100	1,250
Livermore	130	180	2.60	4.10	8.80	2.10	250	400
Newark	80	110	4.00	3.90	8.80	0.90	50	100
North Oakland	370	410	1.75	2.20	8.80	4.85	1,800	2,000
South Oakland	370	410	1.00	0.0	8.80	7.80	2,900	3,200
Oro Loma Sanitary District	230	250	1.25	2.30	8.80	5.25	1,200	1,300
Piedmont	20	30	1.75	2.20	8.80	4.85	100	150
Pleasanton	80	110	1.50	4.10	8.80	2.20	200	250
San Leandro	90	110	2.75	2.30	8.80	2.75	250	300
Union City	90	130	3.50	2.30	8.80	3.00	250	400
County total	2,630	3,170	N.A.	N.A.	N.A.	N.A.	12,475	14,675

[a] Based on Table C-3.

[b] From Table 2-4.

[c] Based on haul costs of:
- \$2.20/tons from T_1
- \$0.0/tons from T_2
- \$2.30/tons from T_3
- \$6.30/tons from T_4
- \$3.90/tons from T_5

[d] For transfer station see Table 2-4.

[e] Includes the cost of disposal.

Table L-7. Economics of Resource Recovery Alternative Assuming No Market for RDF

Waste generation area	Waste quantity, TPD[a]		Haul cost to transfer station[b]	Dollars/ton		Total (cost) or profit	Total (cost) or profit, dollars/day	
	1985	1995		Haul cost to resource recovery facility[c,d]	Net cost of recoverying material[e]		1985	1995
Alameda	180	200	1.75	0.0	7.62	(9.37)	(1,700)	(1,875)
Albany	30	30	5.25	2.20	7.62	(13.07)	(400)	(400)
Berkeley	290	330	1.75	2.20	7.62	(11.57)	(3,350)	(3,825)
Castro Valley Sanitary District	90	100	2.50	2.30	7.62	(12.42)	(1,100)	(1,250)
Dublin-San Ramon Services District	40	60	4.25	4.10	7.62	(15.97)	(650)	(950)
Emeryville	10	10	1.00	2.20	7.62	(10.82)	(100)	(100)
Fremont	310	450	1.00	3.90	7.62	(12.52)	(3,900)	(5,625)
Hayward	220	250	1.50	2.30	7.62	(11.42)	(2,500)	(2,850)
Livermore	130	180	2.60	4.10	7.62	(14.32)	(1,850)	(2,575)
Newark	80	110	4.00	3.90	7.62	(15.52)	(1,250)	(1,700)
North Oakland	370	410	1.75	2.20	7.62	(11.57)	(4,300)	(4,750)
South Oakland	370	410	1.00	0.0	7.62	(8.62)	(3,200)	(3,525)
Oro Loma Sanitary District	230	250	1.25	2.30	7.62	(11.17)	(2,600)	(2,800)
Piedmont	20	30	1.75	2.20	7.62	(11.57)	(250)	(350)
Pleasanton	80	110	1.50	4.10	7.62	(13.22)	(1,050)	(1,450)
San Leandro	90	110	2.75	2.30	7.62	(12.67)	(1,150)	(1,400)
Union City	90	130	3.50	2.30	7.62	(13.42)	(1,200)	(1,750)
County total	2,630	3,170	N.A.	N.A.	N.A.	N.A.	(30,550)	(37,175)

[a]Based on Table C-3.

[b]From Table 2-4.

[c]Based on haul costs of:
$2.20/ton from T_1
$0.0/ton from T_2
$2.30/ton from T_3
$6.30/ton from T_4
$3.90/ton from T_5

[d]For transfer station see Table 2-4.

[e]Includes the cost of disposal.

- Cost-effectiveness depends upon a continuing market for RDF

The alternative of recovering materials from solid waste is compared with the other alternatives at the conclusion of this chapter.

Alternative 4 - Materials Recovery and Energy Production

This alternative contains the programs for facilities that would ensure a market for the energy which might be derived from solid wastes. Based on an evaluation of potential energy markets presented in Appendix G and an evaluation of potential energy processes in Appendix I, electricity was selected as the most marketable and cost-effective energy source for Alameda County.

Description of Facilities. With this alternative, transfer stations and a processing facility would be needed. The five-transfer station scenario with one central processing station as described in Alternative 3 would be expected to operate for this alternative. There are no existing facilities which could use RDF to produce electricity although the City of Alameda is proposing to build such a facility. The costs which have been developed for this alternative are based upon a range of costs for various energy recovery projects which are presented in Appendix I. The cost analysis resulted in a cost of producing electricity of $0.045/kWhr. This did not include the cost of purchasing fuel. The purchase of RDF from the resource recovery plant will raise the cost of producing electricity to $0.075 kWhr. However, this fuel cost would become revenue for the materials recovery facilities which would then show a daily profit of approximately $15,000. The economic summary for this alternative is presented in Tables L-8 and L-9. The average annual cost for this alternative per account is $25 in 1985 and $27 in 1995.

Location of Facilities. This alternative would require the construction of the four new transfer stations discussed in Alternative 2, the resource recovery facility discussed in Alternative 3, as well as an energy production facility. To minimize fuel costs and site development costs the energy production facility should be sited at or near the same site as the resource recovery facility. As discussed in Alternative 3, the resource recovery facility could be located at either the South Oakland or Hayward transfer stations but has been assumed to be located at the South Oakland station for this analysis. All of these facilities are shown on Figure L-4.

Timing of Facilities. Based on the timing of the resource recovery facility, the energy production facility should be constructed approximately four years later. This would allow for an evaluation of the RDF for equipment specification, selection and

Table L-8. Economics of Alternative 4 - Materials Recovery and Energy Production, 1995, millions of dollars/year unless noted

Item	(Cost) or profit
Profit from resource recovery facility[a]	5.4
Fuel cost[b]	(11.6)
Production cost[c]	(14.4)
Electricity revenue[b]	9.6
Net profit, deficit	(11.0)
Cost/account, 1995, dollars	27

[a]From Table M-6 and 365/days/yr operation.

[b]From Table G-13.

[c]Based on 3.2×10^8 kWhr/yr at $0.045/kWhr.

Table L-9. Economics of Alternative 4 - Materials Recovery and Energy Production, 1985, millions of dollars/year unless noted

Item	(Cost) or profit
Profit from resource recovery facility[a]	4.6
Fuel cost[b]	(9.7)
Electricity production cost[c]	(12.2)
Electricity revenue[b]	8.2
Net (deficit) or profit	(9.1)
Average annual cost/account	25

[a]From Table M-6 and 365 days/yr operation.

[b]From Table G-13.

[c]Based on 2.7×10^8 kWhr/yr and $0.045/kWhr.

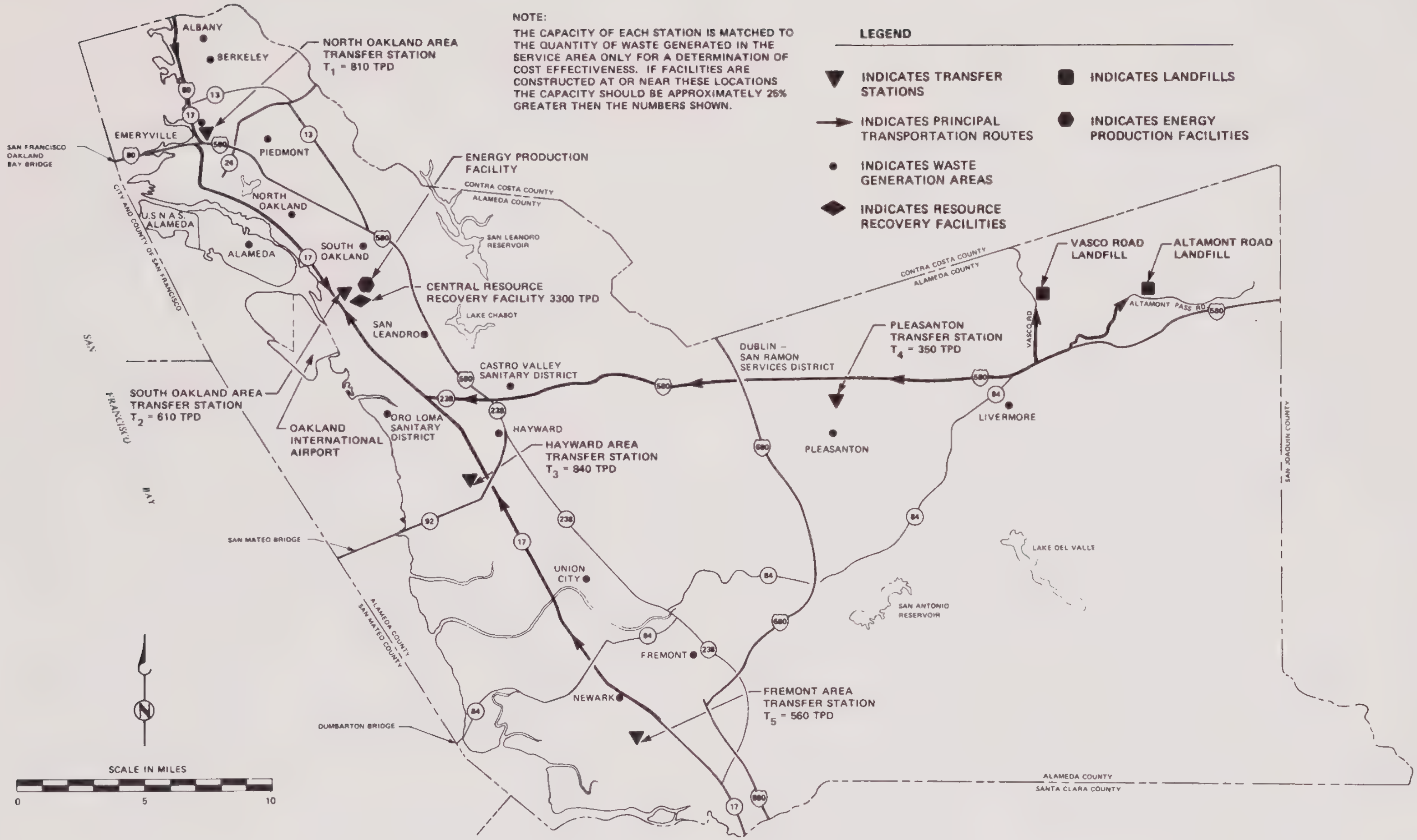


Fig. L-4 Location of Facilities for Alternative 4 - Materials Recovery and Energy Production

purchase for the energy production facility. If, as discussed in Alternative 3, the resource recovery facility is constructed in 1981 or 1982, the energy production facility would be constructed in 1985 or 1986.

Advantages and Disadvantage. The advantages of this program are:

- Maximum conservation of resources
- Lowest cost to the community of all programs except resource recovery with sale of RDF
- Guaranteed market for RDF
- Minimal material to landfill

The disadvantages of this program are:

- Expenditure of approximately $100 million for new facilities
- Difficulty in complying with siting constraints and regulations for power plants

This alternative is compared with the other facilities programs in the next section.

SUMMARY

The economics of the various programs are presented in Table L-10. Alternative 1 is the highest cost program and represents the system that would exist around 1982 when all West County landfills are closed. Alternative 2 and Alternative 4 are more cost-effective than Alternative 1 for the medium- and long-term future. However, Alternative 4 results in a significantly greater reduction in the quantity of processable wastes going to landfill over Alternative 2. The greatest potential for cost-effectiveness lies in Alternative 3 if a market exists for RDF. No market for RDF was found in Alameda County.

The benefits of constructing an energy production facility can be determined by comparing Alternatives 3 and 4. The calculation is completed by comparing the annual cost or profit per ton for Alternative 3 without RDF sales and Alternative 4. In 1985 the difference is a $3 per ton decrease in cost ($12 versus $9), and in 1995 the difference is a $2 per ton decrease in cost ($12 versus $10). The decrease in costs results from the revenues from the sale of recovered materials and energy based on 1977 costs and prices.

Table L-10. Summary of Incremental (Cost) or Profit of Alternative Facilities Programs for Alameda County

Item	Alternative 1		Alternative 2		Alternative 3				Alternative 4	
	Direct long haul		Indirect long haul with transfer stations		Resource recovery				Energy production	
					With RDF sales		Without RDF sales			
	1985	1995	1985	1995	1985	1995	1985	1995	1985	1995
Number of accounts	368,000	405,000	368,000	405,000	368,000	405,000	368,000	405,000	368,000	405,000
Tonnage, million ton/yr	0.96	1.15	0.96	1.15	0.96	1.15	0.96	1.15	0.96	1.15
Annual (cost) or profit, millions of dollars	(14.5)	(17.3)	(9.8)	(11.6)	4.6	5.4	(11.2)	(13.6)	(9.1)	(11.0)
Annual (cost) or profit/account, dollars	(39)	(43)	(27)	(29)	13	13	(30)	(34)	(25)	(27)
Annual (cost) or profit/ton, dollars	(15)	(15)	(10)	(10)	5	5	(12)	(12)	(9)	(10)
Percentage of processible waste to landfill	100	100	100	100	14	14	89	89	19[a]	19[a]

[a]Based on an ash content of 8 percent in the RDF.

ALTERNATIVE MANAGEMENT AND FINANCING SYSTEMS

In the preceding sections, four alternative medium- and long-term solid waste facilities programs have been presented. This section presents management and financing alternatives from among those enumerated in Appendix J suitable for each of these facilities alternatives.

Alternative 1 - Direct Long-Haul by Collection Vehicles

As explained previously, under this alternative all wastes in the county would be transported by collection vehicles to the landfills located in East County.

Management and financing alternatives for this particular alternative (as for all alternatives) are consistent with the general policies of the Alameda County Solid Waste Management Plan. This plan states that local jurisdictions are responsible for the collection and disposal of wastes generated within their borders and for the franchising for such services if so desired. Rates and franchise fees are also considered a local prerogative. There are thus two management/financing alternatives appropriate to the direct haul facilities plan. These are:

1. Public ownership and operation

2. Private ownership and operation

These alternatives are, of course, the very collection and disposal methods currently being used within Alameda County. All jurisdictions, with the exceptions of Berkeley, Alameda, Pleasanton, and a portion of San Leandro, are currently franchising their collection, transport and disposal requirements to the Oakland Scavenger Company (OSC). The cities of Berkeley and San Leandro provide for municipal collection, transport and disposal. Alameda provides for disposal and franchises collection and transport to the Alameda Disposal Company. The City of Pleasanton franchises collection, transport and disposal services within its borders to the Pleasanton Collection Company.

It is recommended that regardless of which management/financing alternative is chosen for the direct haul facilities plan, in the case of franchised service, applications for rate increases be reviewed by the Joint Refuse Rate Committee in the manner set forth in the Price Waterhouse Study of 1972. This report concerns itself primarily with operating and maintenance costs, the appropriate rate of return and accounting procedure policies. Applications for capital expenditures would be reviewed by the Joint Refuse Rate Committee and the Authority. These expenditures should be reviewed

with regard to their necessity, compatibility with the Solid Waste Management Plan, cost and method of financing. This latter procedure will be particularly important in subsequent collection, transfer and disposal and/or recovery alternatives.

Alternative 2 - Indirect Long-Haul through Transfer Stations

Alternative 2 differs from the direct haul alternative in that transfer stations are incorporated into the collection/disposal process. The introduction of transfer stations into the collection/disposal process significantly increases capital costs. It is estimated that the cost of constructing (including engineering and contingencies) the four additional transfer stations will be approximately $14 million. This additional capital expenditure makes the potential interest cost savings resulting from tax-exempt financing significant. There are three viable management/financing alternatives for this facilities plan. They are:

- Public ownership and operation. The Authority can finance and operate the transfer station network.

- Public ownership and private operation. The Authority can finance the capital costs associated with the transfer station network and lease these facilities, at lease payments equal to the debt service requirements, to a private operator. The transfer stations will not be a part of the collection rate base and the franchisee will not earn a rate of return on these facilities.

- Private ownership and operation. The Authority can allow the franchised refuse collectors to both finance and operate the transfer stations as part of franchising the collection, transfer and disposal system. In this case, the transfer stations will be included in the rate base and the franchisee will earn a return on these assets.

The advantages and disadvantages of each of the above management/financing alternatives are summarized in Table L-11. Whichever alternative is chosen, it is recommended that collection costs in each jurisdiction be separated from transfer and disposal costs. The latter costs are necessarily a function of the location of the transfer stations. The location and capacities of these transfer stations have been determined such that the total costs of transfer are a minimum. Therefore the benefit of this minimization of transfer and disposal costs should be shared by the residents of all jurisdictions. This, of course, is the major reason for the regionalization of solid waste management. One equitable method of allocation of these costs is to keep the costs of collection separate from the costs associated with transfer and disposal and allocate the latter costs back to each jurisdiction based on volume

Table L-11. Management/Financing Alternatives for Direct Disposal Using Transfer Stations

Management/Financing Alternative	Advantages	Disadvantages
1. JPA[a] financed and managed	1. Low interest cost. 2. Total control of operation.	1. Requires establishment of JPA operating department and hiring of personnel.
2. JPA financed and privately managed	1. Low interest cost. 2. Expertise in operation.	1. Assumption of financial risk. 2. Limited control of cost and service. 3. Difficult to implement policies over total service area.
3. Privately managed and financed	1. No financial risk. 2. Greater expertise in operation. 3. No burden on debt limitations.	1. Higher capital costs 2. Limited control over costs and service. 3. Difficult to implement uniform policies over total service area.

[a] JPA - Joint Powers Authority. Refers to the Alameda County Solid Waste Management Authority.

of waste generation. Another method would be to determine the total cost of each jurisdiction collecting and disposing of its own solid waste. The sum of these costs less the cost associated with the direct disposal using transfer stations plan is the cost savings resulting from regionalization. This savings can be allocated to each jurisdiction in proportion to the amount of solid waste it contributes to the regional system.

Resource Recovery and Energy Production

The remaining two facilities plan alternatives are fundamentally different than those discussed above. While the above facilities alternatives are concerned only with collection and disposal, the remaining alternatives are additionally concerned with the intermediate step of either recovery of resources and energy recovery. Due to their similarity in facilities, Alternatives 3 and 4 are combined here and a single set of alternatives presented for financing and management.

While collection and disposal are labor-intensive activities requiring relatively little capital and employing well-known operating procedures and technology, resource and energy recovery are capital-intensive and often require state-of-the-art knowledge of both the technology involved and the markets for the recovered products. Because private industry is the main source of resource and energy recovery technology, their involvement would be important to successful implementation of Alternatives 3 and 4. This does not, of course, preclude the Authority or any of the participating jurisdictions from both financing and operating their own resource and energy recovery facilities provided those facilities, their proposed management, and their cost meet the approval of the Authority. Three practical management/financing alternatives exist for resource and energy recovery systems. These are:

- Private Ownership and Operation With Both Debt and Equity Raised From Private Sources. In this case the private owner/operator would have total responsibility for the collection, recovery of resources and energy, and residue disposal. This would most likely require a long-term contract with the private operator including a provision for profit sharing between operator and the authority/local jurisdictions. In addition, the private operator would be responsible for raising from private sources both debt and equity capital.

- Private Ownership and Operation With Debt Raised by Tax-Exempt Financing. The Authority can finance a portion of the capital-related costs through the issuance of municipal revenue bonds (or through the issuance of a

general obligation bond by a participating agency and subsequent lease to the Authority) and leased (or subleased) with benefits of ownership to a private operator. Lease payments would be equal to debt service. The remaining portion could be financed via an equity participation by the private operator. Again, a long-term agreement between the Authority/local jurisdictions and private operator guaranteeing waste stream and specifying profit sharing of any recovered resource and energy profits may be required.

Because there is some question concerning the legality of a public agency issuing tax-exempt debt on the behalf of a private jurisdiction (even if benefits accrue to residents of the public jurisdiction), a variation of the above would be that the debt portion is provided by the issuance of solid waste revenue bonds by the California Pollution Control Financing Authority (CPCFA).

- Public Ownership and Operation. Here the Authority both finances and operates the recovery facilities. The possibility of contracting with a private operator to operate the facilities without the benefit of ownership also exists. Although the cost of capital would be low, depending on the recovery process, the necessary technical expertise might not be available within the Authority.

Again, as described for Alternative 2, collection costs should be separated from transfer, recovery and disposal costs with the former being considered local and particular to the jurisdiction or collection area and the latter being considered regional and allocated throughout the Authority commensurate with waste generation. The advantages and disadvantages of each of the above management/financing alternatives for the resource and energy recovery plans are summarized in Table L-12.

SUMMARY OF FINANCING COSTS

Each of the capital intensive plans were analyzed to determine the effective cost of capital for each of the financing alternatives. The results are summarized in Tables L-13, L-14 and L-15. The analyses presented use only rough estimates of project capital costs and interest rates and are only intended to indicate the differences in effective cost associated with each financing alternative. Detailed calculations of the costs of capital will be made after public hearings and the selection of a single plan. In addition, the cost savings resulting from the adoption of a particular facilities plan will be determined and an equitable method of allocation to each of the participating jurisdictions will be recommended at that time.

Table L-12. Management/Financing Alternatives for Alternatives 3 and 4

Management/financing alternative	Advantages	Disadvantages
1. Private ownership and operation with private equity and debt.	1. Limited risk 2. Technical expertise 3. No burden on municipal debt limits	1. High cost of capital 2. Limited control
2. Private ownership and operation with private equity and tax exempt debt.	1. Low cost of capital 2. Technical expertise 3. Limited risk 4. No burden on municipal debt limits	1. Limited control
3. Public ownership and operation.	1. Low cost of capital 2. Total control	1. Requires staffing of in-house capability

Table L-13. Financing Costs for Alternative 2

Item	Municipal G.O. bonds	Municipal revenue bonds	CPCFA and private equity[a]	Private financing[b]
Face amount of Debt Issue				
Project cost	14,000,000	14,000,000	11,200,000	9,800,000
Underwriting commission	210,000	410,000	168,000	196,000
Bond council	30,000	50,000	25,000	25,000
Printing costs	25,000	30,000	10,000	25,000
Reserve requirements[c]	-	1,412,150	1,180,375	1,329,370
Engineering report	-	30,000	20,000	30,000
Total issue	14,265,000	15,932,150	12,603,375	11,405,370
Proceeds to JPA	14,000,000	14,000,000	11,200,000	9,800,000
Cost[d]				
G.O. bonds at 6 percent	1,234,275	-	-	-
Revenue at 6.30 percent	-	1,412,150	-	-
CPCFA at 7 percent	-	-	1,180,375	-
Private debt at 10 percent	-	-	-	1,329,370
Equity at 16 percent[e]	-	-	448,000	672,000
Total annual cost	1,234,275	1,412,150	1,628,375	2,001,370
Effective cost, percent[f]	8.82	10.09	11.63	14.30

[a]Assumes 80/20 debt/equity ratio.

[b]Assumes 70/30 debt/equity ratio.

[c]One year debt service.

[d]Assumes semi-annual payments for 20 years.

[e]Assumes no issue cost for equity.

[f]Weighted cost.

Table L-14. Financing Costs for Alternative 3 - Resource Recovery

Item	Municipal G.O. bonds	Municipal revenue bonds	CPCFA and private equity[a]	Private financing[b]
Face amount of Debt Issue				
Project cost	46,000,000	46,000,000	36,800,000	32,200,000
Underwriting commission	690,000	1,000,000	552,000	644,000
Bond council	40,000	50,000	40,000	40,000
Printing costs	30,000	40,000	15,000	30,000
Reserve requirements[c]	---	4,583,650	3,868,445	4,347,750
Engineering report	---	40,000	30,000	40,000
Total issue	46,760,000	51,713,650	41,305,445	37,301,750
Proceeds to JPA	46,000,000	46,000,000	36,800,000	32,200,000
Cost[d]				
G.O. bonds at 6 percent	4,045,898	---	---	---
Revenue at 6.30 percent	---	4,583,650	---	---
CPCFA at 7 percent	---	---	3,868,445	---
Private debt at 10 percent	---	---	---	4,347,750
Equity at 16 percent[e]	---	---	1,472,000	2,208,000
Total annual cost	4,045,898	4,583,650	5,340,445	6,555,750
Effective cost, percent[f]	8.80	9.96	11.61	14.25

[a]Assumes 80/20 debt/equity ratio.

[b]Assumes 70/30 debt/equity ratio.

[c]One year debt service.

[d]Assumes semi-annual payments for 20 years.

[e]Assumes no issue cost for equity.

[f]Weighted cost.

Table L-15. Financing Costs for Alternative 4 - Materials Recovery and Energy Production Facilities

Item	Municipal G.O. bonds	Municipal revenue bonds	CPCFA and private equity[a]	Private financing[b]
Face amount of Debt Issue				
Project cost	100,000,000	100,000,000	80,000,000	70,000,000
Underwriting commission	1,500,000	2,000,000	1,200,000	1,400,000
Bond council	50,000	100,000	50,000	50,000
Printing costs	30,000	40,000	15,000	30,000
Reserve requirement[c]	-	9,938,535	8,401,400	9,437,245
Engineering report	-	50,000	40,000	50,000
Total issue	101,580,000	112,128,535	89,706,400	80,967,245
Proceeds to JPA	100,000,000	100,000,000	80,000,000	70,000,000
Cost[d]				
G.O. bonds at 6 percent	8,789,185	-	-	-
Revenue at 6.30 percent	-	9,938,535	-	-
CPCFA at 7 percent	-	-	8,401,400	-
Private debt at 10 percent	-	-	-	9,437,245
Equity at 16 percent[e]	-	-	3,200,000	4,800,000
Total annual cost[f]	8,789,185	9,938,535	11,601,400	14,237,244
Effective cost, percent	8.80	9.94	11.61	14.24

[a]Assumes 80/20 debt/equity ratio.

[b]Assumes 70/30 debt/equity ratio.

[c]One year debt service.

[d]Assumes semi-annual payments for 20 years.

[e]Assumes no issue cost for equity.

[f]Weighted cost.

APPENDIX M

FINAL ENVIRONMENTAL IMPACT REPORT

APPENDIX M

FINAL ENVIRONMENTAL IMPACT REPORT

This appendix includes the draft EIR and the written comments received during the draft EIR review period and responses to those comments.

ENVIRONMENTAL IMPACT

This section presents the environmental setting of Alameda County and assesses the environmental impact of the alternative facilities programs. The setting is described in general terms, since specific sites discussed in the project alternatives have not been identified. Environmental impacts will be addressed in more detail subsequent to selection and identification of site specific solid waste facilities.

ENVIRONMENTAL SETTING

A description of the environmental setting of Alameda County is contained in the following references:

- Solid Waste Management Plan for Alameda County, May 18, 1976.

- Draft EIR for Conditional Use Approval for Proposed Solid Waste Transfer Station, Oakland Scavenger Company, June 1977.

- Draft EIR for Altamont Sanitary Landfill, Alameda County, December 1975.

This section summarizes the information contained within these references describing the geographical characteristics of the study area.

Physical Geography

Alameda County is located on the east side of San Francisco Bay. Within its borders, the county contains 735 sq mi of land and 77 sq mi of San Francisco Bay. Landforms range from low-lying

salt marsh along the bay plain to moderately high uplands and intermontaine valleys. The climate varies from marine type along the bay to fog-shrouded redwood forest in the East Bay hills to semiarid savanna in the eastern areas of the county adjacent to the San Joaquin Valley. In general, physical conditions in the county vary depending upon altitude, topography, and distance from the ocean and bay.

An overall physiographic description of Alameda County is contained in Reference 1, pages III-1 through III-5, and includes discussion of land forms, elevation and slope, areal size, and land use by county planning unit. Planning units of the county are described in Reference 1, pages II-1 and II-3, and are shown on Figure II-2 in Reference 1.

Geology

A generalized description of the geology of Alameda County is given in Reference 1, pages III-6 through III-9. The discussion includes descriptions of the major geological formations and lists the soil and rock types that make up the formations. The East Bay hills are a diverse combination of rock types, ranging in age from upper Cretaceous to Pleistocene. The bay plain west of the foothills is Quaternary alluvium deposits washed down from the hills. The most important aspect of this formation is that because of the varying permeability from layer to layer groundwater is found in aquifers.

East of the East Bay hills in the Livermore Valley, predominant upland formations include marine sedimentary and metasedimentary rocks. Lowlands are composed of recent alluvial deposits.

Seismicity (Geologic Hazards). Two fault systems in the county have had historic fault movements. They are the Hayward Fault, which passes through the urban areas along the foothills west of the East Bay hills, and the Calaveras Fault, which passes through the suburban and rural areas of Sunol and the Livermore and San Ramon valleys. Potentially less important fault systems are described in Reference 1, pages III-9b through III-9d.

Soils. Soil resources in the county are generally described in Reference 1, pages III-10 through III-12.

Climate

Climatic conditions in Alameda County are highly seasonal and are influenced by elevation, proximity to the bay, and wind direction. Reference 1 presents an isohyetal map for Alameda County on page III-26. Ninety percent of the rainfall occurs between November and April. Winds in the west part of the county

during the summer are from the north to west at about 16 mph in mid-afternoon (see Reference 2, page 43). During winter storms, winds are from the southeast to southwest.

Air Quality

Reference 1, page 43, describes air quality conditions in the vicinity of the Davis Street landfill. Air quality is monitored regularly at several locations in the county, including Oakland, Fremont and San Leandro. Parameters measured include carbon monoxide, nitrogen dioxide, sulfur dioxide and total suspended particulates. Values of these parameters are likely to be greater in the vicinity of and downwind from, freeways and other heavy traffic areas. Dust and odors are sometimes present in the vicinity of existing landfills and sewage treatment plants.

Hydrology

Major considerations of hydrology are groundwater and surface water recharge areas, drainage and storage areas, flooding and the relation between these considerations and water quality management in the county.

Descriptions of major drainage basins, watercourses, and surface water storage in the county are contained in Reference 1, pages III-23 through III-28.

Biological Resources

Natural habitats in the western portion of the county include 80,000 acres of uncultivated/undeveloped land or land set aside for parks or other forms of recreation, shoreline marshland, most of which lies between San Leandro and Fremont, dry diked areas and landfills, seasonal freshwater ponds, and isolated hills. Approximately 10,000 acres, or less than 5 percent of the Livermore-Amador Planning Unit, is developed in urban uses. The remainder is used for agriculture. Valley lowlands are cultivated for crop production; upland areas are used for stock grazing or left for open space.

Reference 1, pages III-12 through III-22, lists principal sources of plant and animal life found in Alameda County and discusses the importance of the plant-animal-human relationship.

Cultural Setting

Description of the cultural setting of Alameda County is too broad a topic to be included in a general facilities plan. More appropriately, cultural resources should be discussed in terms of specific projects. Reference 2, pages 47-48, gives the socio-

economic setting in the vicinity of the Davis Street landfill. Reference 3, page 17, briefly describes the setting in the vicinity of the Altamont landfill.

ENVIRONMENTAL IMPACT ASSESSMENT

Four alternative facilities programs are proposed for dealing with solid waste management in Alameda County, and these are described in Appendix L. The alternatives can be generally described as follows:

- Alternative 1 - Collection of solid waste would be continued as the present operation. At the end of the collection route, the collection vehicle would haul the collected waste to either the Vasco Road or Altamont landfills located in the eastern portion of Alameda County.

- Alternative 2 - The current collection system would remain in operation. At the end of the collection route, the collection vehicles would drive to one of several transfer stations located throughout the county. At the transfer stations, the collected wastes would be transferred to larger vehicles for haul to the East County landfills.

- Alternative 3 - The collection of wastes and the operation of the transfer stations would be the same as Alternative 2. However, the transfer vehicles would bring the wastes to a central resource recovery facility. There, recoverable material would be removed from the solid waste stream. Residual material from the resource recovery facility would be hauled to the East County landfills for disposal.

- Alternative 4 - The collection, transfer and resource recovery facilities described in Alternative 3 would be used and an electricity generating station would be constructed. The facility would be designed to burn a refuse-derived fuel produced by the resource recovery facility. Residue from the resource recovery facility and ash from the generating station would be hauled to the East County landfills for disposal.

The general location of the facilities and main transportation corridors are shown on Figures L-1, L-2, L-3 and L-4 for the four alternative programs.

The purpose of this chapter is to identify and assess the environmental impacts associated with implementation of each of the alternatives. The assessment is given in general terms since the proposed alternatives are only conceptual at this point. The assessment will be reevaluated and made more specific after the alternatives have been reviewed and a set of programs have been selected for description in the final plan.

Environmental assessment is basically the process of predicting impacts of the project alternatives. By comparing expected impacts, the best alternative (defined as that which minimizes adverse environmental effect and makes best use of available resources) can be selected. Commonly, unavoidable adverse impacts are identified, but once done so, measures can be taken to mitigate the adverse effect as much as possible.

Major Impacts

The major impacts of the four alternatives are discussed below. The minor impacts are discussed later.

Alternative 1. The major impacts of this alternative will be:

- Increased air pollution from the large number of trucks driving to the East County landfills.
- Increased noise levels along the transportation corridor because of the truck traffic.
- Large amounts of land required for landfill.
- High energy demand (see Appendix K).
- No benefit from recovered materials.

Alternative 2. The major impacts of this alternative will be:

- Land use impacts in the area of the transfer stations.
- Increased noise levels and vehicle traffic in the area of the transfer station and along the transportation corridor.
- Large amounts of land required for landfill.
- No benefit from recovered materials.

Alternative 3. The major impacts of this alternative are:

- Land use impacts in the area of the transfer stations and resource recovery plant.
- Increased noise levels and vehicle traffic in the areas of the transfer stations and resource recovery facility and along the transportation corridors.
- If no market is found for refuse-derived fuel, large amounts of land will be needed for landfill.
- There will be a benefit to society for recovering materials from solid waste.

Alternative 4. The major impacts of this alternative are:

- Land use impacts in the area of the transfer stations, resource recovery facility and electrical generating station.
- Increased noise levels and vehicle traffic in the area of the transfer stations, resource recovery facility and along transportation corridors.
- Increased air pollution in the area of the generating station.
- There will be a benefit to society for minimizing the amount of load required for landfill.
- There will be a benefit to society for maximum recovery of materials from solid waste.

Secondary Impacts

The alternative facilities programs will affect a number of other environmental factors. These are discussed below.

Air Quality. All the alternatives will affect air quality. The closing of West County landfills requires more vehicle traffic to haul the collected waste to the landfills. Resource recovery and energy production (Alternatives 3 and 4) will reduce this truck traffic but will produce other emissions. The energy production facility will emit CO, SO_x, NO_x, particulates, and nonmethane hydrocarbons. A discussion of the air quality aspects of energy production is presented in Appendix I.

Geologic and Soil Conditions. No alternatives presented in this report are site specific. Construction of any facilities for any of the alternatives will affect local soil conditions. Evaluation of these impacts will have to be undertaken when specific facilities are proposed and construction is initiated.

Hydrologic Conditions. Construction of new facilities will affect local hydrologic conditions. New development of any kind increases storm runoff. The impact on hydrologic conditions must be evaluated on a site-specific basis when the magnitude of the impact can be evaluated.

Plant and Animal Communities. The extent of the adverse impact on these communities will depend on site-specific analysis. Direct long haul should not have a significant impact. In the other three alternatives, the impact must be examined on site-specific basis.

Historical Features. These are again site-specific impacts which can only be evaluated when facilities are located and construction is proposed.

Land Use and Public Facilities. Transfer stations, resource recovery and power generating facilities will affect land uses and may require modifications in zoning and future uses. The more land used for solid waste facilities, the less land will be available for other uses. Alternatives 1 and 2 will require large amounts of land for landfill while Alternatives 3 and 4 will require less land for landfill but more for the construction and operation of the facilities.

Traffic conditions resulting from each of the alternatives except direct long-haul would alter and be affected by existing traffic patterns along access routes to the facilities.

Economic and Social Impacts

Economic impacts of the alternative programs are closely related to resource recovery and use of RDF. There is no economic benefit from resource recovery and use of RDF with Alternatives 1 and 2, because with these alternatives all solid waste is land-filled. The extent of economic benefit related with Alternatives 3 and 4 will depend on specific facilities selected and to what degree refuse is sorted and valuable materials are extracted. Other economic impacts may be related to local use of the recovered materials. The most important such use is generation of electrical power from RDF.

The construction and operation of the facilities required for Alternatives 2, 3 and 4 will affect neighborhoods and localities where the facilities are constructed. Vehicle traffic to the facilities will also affect local communities. The evaluation of the extent of these impacts can only be completed when specific sites are proposed for the facilities.

Noise. Noise levels due to direct long haul operations will not increase above existing levels or above levels associated with routine collection. Noise levels will increase, however, for alternatives involving resource recovery and power generation. Vehicle noise will increase along access routes to and from and in the vicinity of the transfer stations and resource recovery facilities. There will be increased noise also as a result of resource recovery machinery operation and power generation.

Do-Nothing Alternative

Closure of local landfills in west Alameda County is mandated by law. Alternative 1 is in part a do-nothing alternative, since it involves collection vehicles driving directly to east Alameda County landfills instead of to West County landfills. Specific identification of the do-nothing alternative is complicated, however, since it means doing nothing beyond implementation of the short-term program, which has not yet taken place.

GROWTH INDUCING IMPACT OF ALTERNATIVE FACILITIES PROGRAM

Since there presently is a functioning solid waste collection and disposal system in Alameda County, there should not be any growth inducing impacts as a result of adopting a medium- and long-term solid waste facilities program. The adaptation of a facilities program is a growth accommodating rather than a growth inducing action. Population projections developed in Appendix B of the draft EIR are in accordance with the projections made by the State Department of Finance and the Alameda County Planning Department.

IRREVERSIBLE ENVIRONMENTAL CHANGES WHICH WOULD BE INVOLVED IN THE RECOMMENDED PROGRAMS

Irreversible environmental changes would include the use of nonrenewable resources for construction. The commitment of resources would be the greatest for Alternative 4 with its four new transfer stations, a processing facility, and an energy conversion

facility; the second greatest for Alternative 3 with its four transfer stations and a processing facility; the third greatest for Alternative 2 with its four transfer stations, and the least irreversible impacts are associated with Alternative 1.

Fuel consumption for the four alternatives also represents a use of nonrenewable resources. The energy consumption of the four alternative facilities programs are presented in Appendix K.

THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Each alternative has a set of facilities which fit present environmental uses in that surface transportation will use existing routes and that transfer, processing and energy conversion facilities will be placed in areas zoned for industrial purposes. Since this planning is not site specific it is possible only to recommend land use zoning purposes. The most significant relationships between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity are in Alternative 4, the energy conversion program.

MITIGATION OF ENVIRONMENTAL IMPACTS

The impacts of the various alternatives can be mitigated by careful site selection and proper operation of the facilities. Use of noise attenuation systems and air pollution control systems will minimize local impacts while traffic evaluations should minimize neighborhood disruptions. The identification of environmental impacts and the mitigating measures to be undertaken to lessen these impacts can only be completed after selection of a medium- and long-term facilities program when specific locations for facilities are proposed.

State of California

The Resources Agency

COMMENT 1

Memorandum

To : L. Frank Goodson
Projects Coordinator
The Resources Agency

Mr. William Fraley
Alameda Co. Solid Waste Mgt.
399 Elmhurst Street
Hayward, CA 94544

Date : June 20, 1978

From : Department of Conservation
Division of Mines and Geology—San Francisco 94111

Subject: SCH 78052989, Solid waste facility programs, Alameda Co.

The geologic discussion in the subject Draft EIR is adequate for this stage of development of the solid waste facilities program. When a specific program has been selected a more detailed and site specific study and discussion of the geologic impact should be made.

Charles C. Bishop
CHARLES C. BISHOP
Assistant District Geologist
San Francisco District Office
R.G. 3156

CCB/jt

cc: R.M. Stewart

APPROVED:

James F. Davis
James F. Davis
State Geologist
R.G. 3468

APPROVED:

Land Resource Protection Unit
DATE: June 26 78

RESPONSE TO COMMENT 1

No comment.

State of California COMMENT 2 THE RESOURCES AGENCY

Memorandum

To : 1. Mr. L. Frank Goodson
Projects Coordinator
Resources Agency, 13th Floor
Resources Building
2. Alameda County Solid Waste
Management Authority
399 Elmhurst Street
Hayward, CA 94544

Date: JUL 10 1978

In Reply Refer To: 420:DC

(916) 322-9875

From: STATE WATER RESOURCES CONTROL BOARD
Division of Planning and Research
P. O. Box 100, Sacramento, California 95801

Subject: REVIEW OF NOTICE OF INTENT: SCH 78052989--ALTERNATIVE MID-LONG TERM SOLID WASTE FACILITIES, ALAMEDA COUNTY

Introduction:

We have coordinated the review of the subject environmental document with the Hydrogeologic/Geotechnical Section of the State Board and the California Regional Water Quality Control Board, San Francisco Bay Region.

Recommendation:

The final EIR should be revised to discuss the following comments.

General Comments:

1. Existing Active Disposal Site

The existing waste disposal sites must comply with the Regional Board's Minimum Criteria for Proper Closure of Class II Solid Waste Disposal Sites, Resolution No. 77-7 (attached). Discuss in the plan compliance with these requirements.

2. Expansion of Any Existing Active Disposal Site

Any proposed expansion of a landfill must comply with state regulations as described in Chapter 3, Subchapter 15 of Title 23 of the California Administrative Code (Section 2550 through Section 2552). Discuss in the plan compliance with these requirements.

1. Mr. L. Frank Goodson -3-
2. Alameda County Solid Waste Management Authority

JUL 10 1978

cc: California Regional Water Quality Control Board, San Francisco Bay Region
1111 Jackson Street, Room 6040
Oakland, CA 94607

COMMENT 2

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

RESOLUTION NO. 77-7

MINIMUM CRITERIA FOR PROPER CLOSURE OF
CLASS II SOLID WASTE DISPOSAL SITES

I. WHEREAS, experience has shown that Class II solid waste disposal sites can be sources of serious water pollution problems even after their use has been terminated, unless properly closed, and

II. WHEREAS, these problems may include: odors, discharge of leachate, exposed refuse due to inadequate cover, and ponding of refuse-polluted water on the site, and

III. WHEREAS, Section 2535 of the California Administrative Code provides as follows:

> Completion of Disposal Operations. (a) Prior to cessation of disposal operations at a waste disposal site, the operator shall submit a technical report to the appropriate regional board describing the methods and controls to be used to assure protection of the quality of surface and groundwaters of the area during final operations and with any proposed subsequent use of the land. This report shall be prepared by or under the supervision of a registered engineer or a certified engineering geologist.
>
> (b) The methods used to close a site and assure continuous protection of the quality of surface and groundwater shall comply with waste discharge requirements established by the regional board.
>
> (c) The owner of the waste disposal site shall have a continuing responsibility to assure protection of useable waters from the waste discharge, and from gases and leachate that are caused by infiltration of precipitation or drainage waters into the waste disposal areas or by infiltration of water applied to the waste disposal areas during subsequent use of the property for other purposes, and

IV. WHEREAS, the establishment of minimum criteria for proper closure of Class II solid waste disposal sites is desirable to protect the quality of waters of the State and to alert site owners and operators as to their specific responsibilities, and

RESPONSE TO COMMENT 2

Response to General Comments

1. In the medium- and long-term, any waste disposal sites which are closed must comply with the Regional Board's Minimum Criteria for Proper Closure of Class II Solid Waste Disposal Sites, Resolution No. 77-7.

2. In the medium- and long-term, any waste disposal sites which are closed must comply with state regulations as described in Chapter 3, Subchapter 15 of Title 23 of the California Administrative Code.

3. This plan is not site specific. The items for transfer stations will be a part of future site specific EIR's.

Response to Specific Comments

1. The comment has been incorporated.

2. The comment has been incorporated.

3. The comment has been incorporated.

COMMENT 3

June 27, 1978

04-Ala-Gen.

Comments of Clatrans, District 4, concerning the Draft Environmental Impact Report for the Alternative Medium and Long Term Solid Waste Facilities Programs for Alameda County, State Clearinghouse No. 78052989.

In our opinion, the DEIR should include a discussion of the traffic impacts of the project on the State highways.

Thank you for the opportunity to comment on this DEIR. We would appreciate receiving a copy of the Final EIR.

VERNON J. RICHEY
Deputy District Director

RECEIVED
JUL 11 1978
Office of Planning & Research

RESPONSE TO COMMENT 3

The plan is not site or vehicle specific since it is a medium- and long-term plan. The traffic impacts of vehicles in 7 to 15 years is uncertain today and must be considered as a part of the future site specific EIR's.

State of California

4

RECEIVED
JUL 24 1978
Office of Planning & Research

COMMENT 4

Department of Health Services

Memorandum

To : Health and Welfare Agency
Attention: Assistant to the Secretary, Operations
915 Capitol Mall, Rm. 200

Date : July 7, 1978

Subject: Draft Environmental Impact Report and Alternative Mediu and Long Term Solid Waste Facilities Program - SCH 78052989

From : Environmental Health Services Branch

In reviewing the Draft EIR, the State Department of Health has comments on the following issues:

Hazardous Materials Management Section

The Draft EIR is not directly concerned with the management of hazardous wastes, which are stated to include: industrial hazardous waste, pesticides, radioactive waste and infectious waste. However, a review of the sources and amounts of these wastes in Alameda County and the agencies with administrative and management responsibilities for the wastes is given in Appendix A.

There are a few inaccuracies in Appendix A that are noteworthy:

1. On page A-5 it is stated that hazardous wastes are disposed of at sites outside the county, the most significant sites being the Pacific Reclamation and Disposal Site at Benicia and the Sierra Reclamation and Disposal Site at Martinez. These are now respectively, IT Corporation of Solano County and IT Corporation of Contra Costa County. The Sanitary Landfill Class I Site at Richmond should also have been mentioned.

2. Table A-3, page A-6, lists the agencies responsible for management of industrial hazardous wastes in Alameda County. In our view the programs of these agencies are inadequately stated.

Vector Biology and Control Section

The Draft EIR does not address public health aspects of the proposed solid waste facility program alternatives. Solid waste has been demonstrated to be associated with some diseases, particularly in areas that are without general sanitation. A properly maintained solid waste collection and disposal operation minimizes and, when possible, eliminates any of the public health risks. It is therefore recommended that adequate safeguards be considered in the design of the solid waste collection and disposal unit processes.

Original signed by
Kenneth Buell

Kenneth Buell

cc: State Clearinghouse
bcc: Harvey Collins
David Storm

RESPONSE TO COMMENT 4

Hazardous Materials Management Section

1. The comment has been incorporated.

2. No comment.

Vector Biology and Control

Adequate safeguards will be considered in the design of medium- and long-term solid waste collection and disposal unit processes. This consideration will appear in the site specific projects at a future time.

SUMMARY MATRIX

CEQA Item	Alternative 1	Alternative 2
Description of Project	page L-8	page L-13
Description of Environmental Setting	page M-1	page M-1
Environmental Impact of the Proposed Action	page M-4	page M-4
Adverse Environmental Effects Which Cannot be Avoided if the Proposal is Implemented	page M-4 page M-6	page M-4 page M-6
Mitigation Measures Proposed to Minimize the Impact	page M-10	page M-10
Alternatives to the Proposed Action	page L-13 page L-16 page L-22 Appendix E Appendix H Appendix I	page L-8 page L-16 page L-22 Appendix E Appendix H Appendix I
Relationship Between Local Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity	page M-10	page M-10
Any Irreversible Environmental Changes Which Would be Involved in the Proposed Action Should it be Implemented	page M-11	page M-11
Growth Inducing Impact of the Proposed Action	page M-11	page M-11
Energy Demands	page K-3	page K-3

SUMMARY MATRIX

CEQA Item	Alternative 3	Alternative 4
Description of Project	page L-16	page L-22
Description of Environmental Setting	page M-1	page M-1
Environmental Impact of the Proposed Action	page M-4	page M-4
Adverse Environmental Effects Which Cannot be Avoided if the Proposal is Implemented	page M-4 page M-6	page M-4 page M-6 page I-48
Mitigation Measures Proposed to Minimize the Impact	page M-10 page H-2 page H-3 page H-4 page H-5 page H-8	page M-10 page H-2 page H-3 Page H-4 page H-5 page H-8 page I-47
Alternatives to the Proposed Action	page L-8 page L-13 page L-22 Appendix E Appendix H Appendix I	page L-8 page L-13 page L-16 Appendix E Appendix H Appendix I
Relationship Between Local Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity	page M-11	page M-11
Any Irreversible Environmental Changes Which Would be Involved in the Proposed Action Should it be Implemented	page M-11	page M-11
Growth Inducing Impact of the Proposed Action	page M-11	page M-11
Energy Demands	page K-3	page K-3

REFERENCES

1. Alameda County Solid Waste Management Plan, adopted by the Alameda County Board of Supervisors, May 18, 1976.

2. Technical Supplement to the Draft EIR on a Solid Waste Transfer Station proposed by the Oakland Scavenger Company, San Leandro, June 1977.

3. Draft Environmental Impact Report, Altamont Sanitary Landfill, Alameda County Planning Department, December 1975.

APPENDIX N

BACKGROUND MATERIAL USED IN DETERMINING 2,300 TONS PER DAY CAPACITY OF THE DAVIS STREET TRANSFER STATION

APPENDIX N

BACKGROUND MATERIAL USED IN DETERMINING 2,300 TPD CAPACITY OF THE DAVIS STREET TRANSFER STATION

The information in Appendix N is presented to support the short-term actions which affect the medium- and long-term facilities plan. The short-term actions are described in Chapter 1. The short-term actions will be integrated with the medium- and long-term facilities plan during future planning activities.

This information was developed by the staff of the Alameda County Solid Waste Management Authority from the transcripts and tapes of the proceedings.

The Alameda County Solid Waste Management Authority on September 7, 1978, approved a system of five transfer stations within the County in the medium- and long-term plan. At the same meeting under a separate motion, they approved a transfer station at Davis Street with a capacity of 2,300 TPD. The Authority also determined at the September 7, 1978 meeting that the proposed 2,300 TPD transfer facility was in conformance with the official county plan.

These actions were based on the record submitted to the Authority:

1. Documentation submitted by Oakland Scavenger Company July 13, 1978. Excerpts are in the following pages.

2. Long discussions by Authority Members at the September 7, 1978 meeting with representatives of Oakland Scavenger Company. It was generally concluded by Authority Members prior to voting that:

   - Based on evidence submitted, there would be a one-time capital expenditure of $1,200,000 to "oversize" the Davis Street facility to 2,300 TPD rather than redesign the facility to 1,200 TPD and bear the burden of $7,000,000/year for the cost of long haul while the facility was being redesigned. The $1,200,000 one-time capital cost would be recovered in three months.

Representatives of Oakland Scavenger Company assured Authority members that if cost-effective, the facility could be underutilized; that it would be flexible enough to be used as a smaller transfer facility and as a resource recovery plant, which would permit construction of an additional transfer facility at another location.

THE DAVIS STREET

TRANSFER STATION AND RESOURCE RECOVERY COMPLEX

PRESENTED BY: THE OAKLAND SCAVENGER COMPANY

PRESENTED TO: THE ALAMEDA COUNTY SOLID WASTE MANAGEMENT AUTHORITY

JULY 13, 1978

EXCERPTS

DAVIS STREET TRANSFER STATION

SIZE REDUCTION - EFFECT ON CAPITAL COSTS

FIVE STATION PLAN SHOWS 610 TPD ON 7-DAY BASIS
CORRESPONDING DESIGN CAPACITY - 1100 TPD

PRESENT DAVIS STREET DESIGN CAPACITY -	2200 TPD
REDUCTION IN CAPACITY -	1100 TPD, OR 50%

HOW MUCH COST SAVINGS?

BUILDING REDUCED BY 80 FT. LENGTH OR 16,000 SF @ $40

	= $640,000
SELECT FILL UNDER BUILDING REDUCED	273,000
UTILITIES AND PAVING AND CONTINGENCY	269,000
TOTAL SAVING - APPROXIMATELY	$1,182,000

POTENTIAL SAVINGS $\frac{1132}{*4726}$ OR 25%

CAPACITY REDUCTION = 50%

*$4,726,000 IS BASIC TRANSFER STATION COST

COST OF DELAYING DAVIS STREET TRANSFER STATION FOR FIVE TRANSFER STATION ALTERNATIVE

COMPLETION DATES AND MONTHS DELAY

	COMPLETION DATE	MONTHS DELAY
CURRENT CONSTRUCTION SCHEDULE FOR FULL-SIZED TRANSFER STATION	(E.O.M.) 4/80	BASELINE
REDESIGN DELAY		
SCALED DOWN VERSION OF TRANSFER STATION 610 TPD (BASED ON 365 DAYS PER YEAR) TO BE CONSTRUCTED AT DAVIS STREET (IN LIEU OF SOUTH OAKLAND SITE)	6/80	2
TWO TRANSFER STATIONS		
(NORTH OAKLAND AND HAYWARD SITES) (6/80 TO 10/83 = 40 MONTHS)	10/83	40

WASTE GENERATION (B & C REPORT TABLE C-3)

WASTE GENERATION AREA	TONS/DAY 1977	TONS/DAY 1985	ESTIMATED AVERAGE TPD 6/79-10/83
BERKELEY	265	290	
ALBANY	30	30	30
CASTRO VALLEY SANITARY DIST.	75	90	82
EMERYVILLE	10	10	10
HAYWARD	190	220	205
OAKLAND	670	740	705
ORO LOMA SANITARY DIST.	190	230	210
PIEDMONT	20	20	20
SAN LEANDRO	80	90	85
TOTAL	1265	1430	1347

COST OF DELAYING DAVIS STREET TRANSFER STATION FOR FIVE TRANSFER STATION ALTERNATIVE (CONT'D)

DIRECT HAUL COST:

BERKELEY LANDFILL		WILL HANDLE OWN DISPOSAL UNTIL NORTH OAKLAND SITE AVAILABLE
DIRECT HAUL COST ASSOCIATED WITH REDESIGN & CONSTRUCTION DELAY FOR SCALED DOWN VERSION OF DAVIS STREET TRANSFER STATION		(000's)
(1265 TPD x 60 DAS. x 66 MILES x 17¢/TON MILE)		$852
DIRECT HAUL COST DURING CONSTRUCTION PERIOD OF TWO TRANSFER STATIONS (NORTH OAKLAND & HAYWARD SITES)		
TOTAL TPD	1347	
LESS - DAVIS STREET TRANSFER STATION	(610)	
DIRECT HAUL TONAGE	737	
(737 TPD x 40 MOS. x 66 MILES x 17¢/TON MILE)		$10,051
DIRECT HAUL COST		$10,903